*A prospective study of*

# COMPARISON OF RADIOLOGICAL AND FUNCTIONAL OUTCOME IN PATIENTS WITH FRACTURE SHAFT OF HUMERUS TREATED WITH INTERLOCKING NAILING AND WITH PLATE OSTEOSYNTHESIS

Dissertation submitted to

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**BRANCH –II**

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## CERTIFICATE

This is to certify that **Dr.GANESH ANAND KUMAR.T,** post graduate student (2009-2011) in the Department of Orthopedic Surgery**, Kilpauk Medical College ,** has done dissertation on **''COMPARISON OF RADIOLOGICAL AND FUNCTIONAL OUTCOME IN PATIENTS WITH FRACTURE SHAFT OF HUMERUS TREATED WITH INTERLOCKING NAILING AND WITH PLATE OSTEOSYNTHESIS''** under my guidance and supervision in partial fulfillment of the regulation laid down by the **'THE TAMILNADU DR MGR MEDICAL UNIVERSITY, CHENNAI 32'** for M.S.(Orthopaedic Surgery) degree examination to be held in April 2011.

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Above all it is the blessimgs of the **Almighty** that made this study a successful one and to Him I offer my sincere prayers.

# DECLARATION

I , **Dr. GANESH ANAND KUMAR.T**, solemnly, declare that Dissertation titled ‘‘**COMPARISON OF RADIOLOGICAL AND FUNCTIONAL OUTCOME IN PATIENTS WITH FRACTURE SHAFT OF HUMERUS TREATED WITH INTERLOCKING NAILING AND WITH PLATE OSTEOSYNTHESIS** is a Bonafide work done by me at Kilpauk Medical College between 2009 to 2010, under the guidance and supervision of our Head of the Department and my Unit Chief , **Prof.K.V. CHANDRASEKARAN M.S. (Ortho), D.Ortho.**

This dissertation is submitted to “**THE TAMILNADU DR MGR MEDICAL UNIVERSITY”**, towards partial fulfillment of regulations for the award of M.S.DEGREE BRANCH II in Orthopedic Surgery.

Place: Chennai

Date : **(DR..GANESH ANAND KUMAR.T)**

## CONTENTS

# INTRODUCTION

Fracture of the shaft of the humerus represents 3 to 5 % of all fractures [1]. Current research in this area focuses on defining the incidence and health care resources needed to treat these fractures, refining the indications for surgical intervention, decreasing the surgical failure rate through new implants and techniques, and minimizing the duration and magnitude of disability post injury.

The successful treatment does not end with bony union but the current emphasis is on a holistic approach of patient care. The treatment of the humeral shaft fractures demands a knowledge of anatomy, surgical indications ,techniques and implants, and patient function and expectations.

The treatment methods for fracture shaft of humerus includes

1.Conservative treatment like

A. Coaptation splint:

It is indicated for acute humeral shaft fractures with minimal shortening and for short oblique or transverse fracture patterns.

The disadvantages are irritation of the patient's axilla and splint slippage.

B. Velpeau bandage (Thoracobrachial immobilization)[2]**:**

It is indicated for minimally displaced or non displaced fractures that do not require reduction.

It may be exchanged for functional bracing 1 to 2 weeks after injury.

C. Hanging arm cast :

Indications include

Displaced midshaft humeral fractures with shortening, particularly spiral or oblique patterns.

The patient must remain upright of semiupright at all times with the cast in a dependent position for effectiveness.

D. Functional bracing :

This utilizes hydrostatic soft tissue compression to effect and maintain fracture alignment while allowing motion of adjacent joints.

It is typically applied 1 to 2 weeks after the fracture is treated with hanging arm cast or coaptation splint.

2. Surgical treatment

Plate osteosynthesis

Intramedullary nailing

External fixation

Mckee divided the indications for operative treatment into 3 categories

1.**Fracture indications**

- Failure to obtain and maintain adequate closed reduction

  Shortening >3 cm

  Rotation >30 degrees

  Angulation >20 degrees

- Segmental fractures
- Pathologic fractures
- Intra-articular extension

  Shoulder joint

  Elbow joint

2. **Associated injuries**

   Open wound

   Vascular injury

   Brachial plexus injury

   Ipsilateral forearm fractures

Ipsilateral shoulder or elbow fractures

Lower extremity fractures requiring upper extremity weight bearing

Burns

High-velocity gun shot injury

Chronic associated joint stiffness

3.**Patient indications**

Multiple injuries—polytrauma

Head injury Glasgow Coma Scale ≤8

Chest trauma

Poor patient tolerance, compliance

Unfavorable body habitus

Morbid obesity

Large breast

The goal of operative treatment of humeral shaft fractures is to re-establish length, alignment and rotation with stable fixation that allows early motion and ideally early weight bearing on the fractured extremity.

The Plate osteosynthesis remains the gold standard of fixation of humeral shaft fractures against which other methods can be compared.Although it has high union rate ,it involves extensive dissection and soft tissue stripping,chance of injury to radial nerve and infection is present.

The Intramedullary interlocking nailing has the advantage of minimal surgical exposure and soft tissue dissection ,with stable fixation and rotational control.It can be done antegrade or retrograde manner.

## AIM OF THE STUDY

The aim of this study is to compare the Radiological and Functional outcome in patients with fracture shaft of the humerus treated with Dynamic Compression plating and those treated with Intramedullary Interlocking nailing.

## REVIEW OF LITERATURE

Heineman et al [3] have done a meta analysis of patients with fracture of humeral shaft treated with plate fixation and those treated with intramedullary nail fixation and found that there is no significant difference between the two groups.

Bhandari et al. [4] have done another meta analysis comparing compression plating and intramedullary nail fixation for fracture shaft of humerus and concluded that Plate fixation may reduce the risk of reoperation and shoulder impingement.

Chapman JR et al [5] in a randomized control study of 84 patients compared plate osteosynthesis and locked intramedullary nail fixation for diaphyseal fracture of humerus concluded that both provide predictable methods for achiving fracture stabilization and ultimate healing.

McCormack RG et al [6] have done a randomized trial in 44 patients comparing fixation of fracture shaft of humerus with dynamic compression plate and with intramedullary nail and concluded that open reduction and internal fixation with a DCP remains the best treatment for unstable fractures of the shaft of the humerus and fixation by a IMN nail may be indicated for specific situations, but is technically more demanding and has a higher rate of complications.

Flinkkila T et al [7] studied about the recovery of shoulder joint function after humeral shaft fracture comparing between Plate osteosynthesis and antegrade IM nailing and concluded that shoulder joint ROM and strength does not recover to normal after humeral shaft fracture and antegrade IM nailing if performed properly is not responsible for shoulder joint impairment.

Huerta Lazcarro J et al [8] in their study compared the prevalence of radial nerve lesion after fixation of humeral shaft fractures with dynamic compression plate and intramedullary nailing and concluded that the surgical technique with DCP represents a higher incidence of radial nerve lesion propably due to the exposure and proximity to the radial nerve during surgery.

S Raghavendra et al [9] in their study on internal fixation of the shaft of the humerus by dynamic compression plating or intramedullary nail have concluded that though there was no significant difference between plating or nailing in terms of union , compression plating is the preferred method with better preservation of joint function and lesser need for secondary bone grafting for union.

Amit B Putti et al [10] in their study of comparison between Locked intramedullary nailing versus dynamic compression plating for humeral shaft fractures showed that complication rates were higher in Intramedullary nailing group whereas functional outcome were good in both modalities.

Rodriguez – Merchan EC [11] showed in their study of comparing compression plating versus Hackethal nailing in closed humeral shaft fractures showed better functional outcome in compression plating group and need for second surgical procedure was more in nailing group.

Gamal Hosny Abdel Maksod,Md[12] et al in their study compared both procedures and concluded that dynamic compression plating of humeral shaft fractures resulted in a higher rate of union in a shorter duration of time with less complications than antegrade intrmedullary interlocking nailing.

Kiran Singisetti and M.Ambedkar[13] in their prospective comparative study on Nailing versus Plating in humerus shaft fractures concluded that higher rate of excellent and good results were seen in Plating group.

M. Changulani et al[14] in their study inferred that complications like infection were found to be higher with Plating as compared to shortening of the arm and restriction of shoulder movements due to impingement were higher in the Interlocking group.

Lin, Jinn MD[15] in his article on treatment of Humeral Shaft Fractures with Locked Nail and comparison with Plate Fixation showed that Humeral locked nailing offered a less invasive surgical technique and more favorable treatment results than did plate fixation.

Stern PJ et al[16] in their study about intramedullary fixation of humeral shaft fractures found that complications developed in 67% of cases and 64% required at least one additional operative procedure.

Meekers et al[17] ,from their study recommended the use of plate and screw fixation as the primary treatment for fractures of the humeral shaft except for pathological fractures , very obese patients and open fractures.

Ingman et al[18] showed in theirstudy that closed locked intramedullary nailing for humeral shaft fractures can reliably provide secure fixation with acceptable risks and suggested as the method of choice for osteoporotic and pathological fractures.

Kesemenli CC et al[19],in their study comparing the results of Intramedullary nailing and compression plate fixation in the treatment of humerus fractures showed that despite higher non union rates, intramedullary nailing may be the method of choicds in treatment of humerus fractures because of low morbidity, small dissection of soft tissues and greater ease of application.

Niall DM et al[20], in their study about the outcome after Compression Plating in humeral shaft fractures in 49 patients showed no complications with union rate of 96% and concluded Plating as the surgical treatment of choice.

Arpacioglu MO et al[21],studied about the outcome after Intramedullary interlocking nailing in 43 patients and showed that it provides adequate fixation and early mobilization and results in satisfactory radiographic and functional results.

Ajmal et al[22],studied about the functional results in 33 patients after Ante grade Intramedullary Nailing of humeral shaft fractures leads to a substantial risk of non union and impairment of shoulder function.

Dykes, Daryll C et al[23], compared the two procedures and suggested Plating for fractures of shaft of humerus with distal extension, nerve injury, or vascular injury and Nailing for fractures with proximal extension, segmental or comminuted fractures and pathologic fractures.

Baltov et al[24] in comparison of both the methods inferred that Interlocking nailing reduces the risk of nerve injury and infection provides more stability in segmental, complex and juxta articular fractures and no significant differences in the term of healing in both groups.

# ANATOMY

The humerus is a long bone which has a cylindrical central part called the shaft and enlarged upper and lower ends.The anterior aspect of the upper end shows a prominent vertical groove called the intertubercular sulcus.

The head is rounded and has a smooth articular surface. It is directed medially and also backwards and upwards.The upper end also shows two prominences called the greater and lesser tubercles(or tuberosities).These two tubercles are separated by intertubercular sulcus (or the bicipital groove).

There are two distinct regions of the upper end of the humerus that are referred to as the neck.The junction of the head with the rest of the upper end is called the anatomical neck,while the junction of the upper end with the shaft is called the surgical neck.

Humeral shaft is one in which main fragment is distal to the surgical neck of the proximal humerus and proximal to the supracondylar ridge distally. Proximally the humerus is roughly cylindrical in cross section tapering to triangular shape distally.


**Part A:**
1. Subscapularis.
2. Triceps (medial head).
3. Coracobrachialis.
4. Pronator teres (humeral head).
5. Common flexor origin.
6. Supraspinatus.
7. Pectoralis major.
8. Lastissimus dorsi.
9. Teres major.
10. Deltoid.
11. Brachialis.
12. Brachioradialis.
13. Extensor carpi radialis longus.
14. Common extensor origin.

**Part B:**
1. Infraspinatus.
2. Teres minor.
3. Triceps (lateral head).
4. Deltoid.
5. Brachialis.
6. Triceps (medial head).
7. Anconeus.

The shaft of the humerus has three borders[26]: anterior, medial and lateral.These are readily identified in the lower part of the bone.

The **anterior border** becomes continuous with the anterior margin of the greater tubercle.

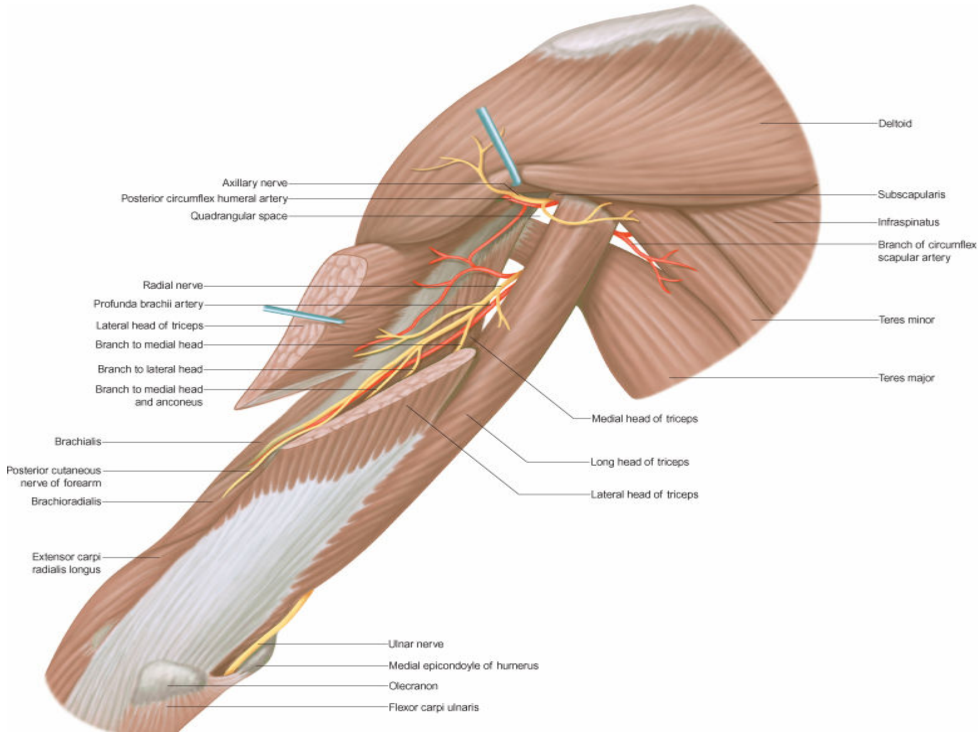
The **medial border** can be traced to the lower end of the lesser tubercle.

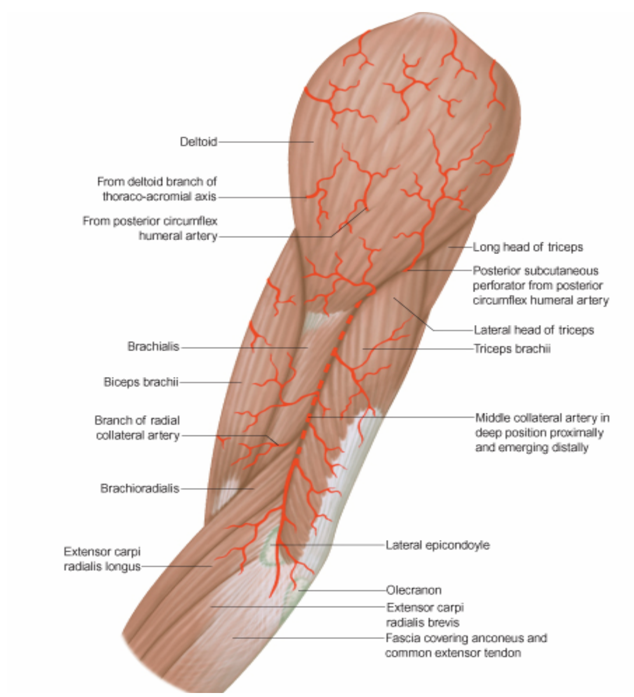
The lower part of the **lateral border** can be seen from the front and its upper part runs upwards on the posterior aspect of the bone.

The three borders divide the shaft into three surfaces. The **anterolateral surface** lies between the anterior and lateral borders.the **anteromedial surface** lies between the anterior and medial borders.The **posterior surface** lies between the medial and lateral borders.

The **anterolateral surface** has a V shaped rough area called the

# MUSCLE ATTACHMENTS

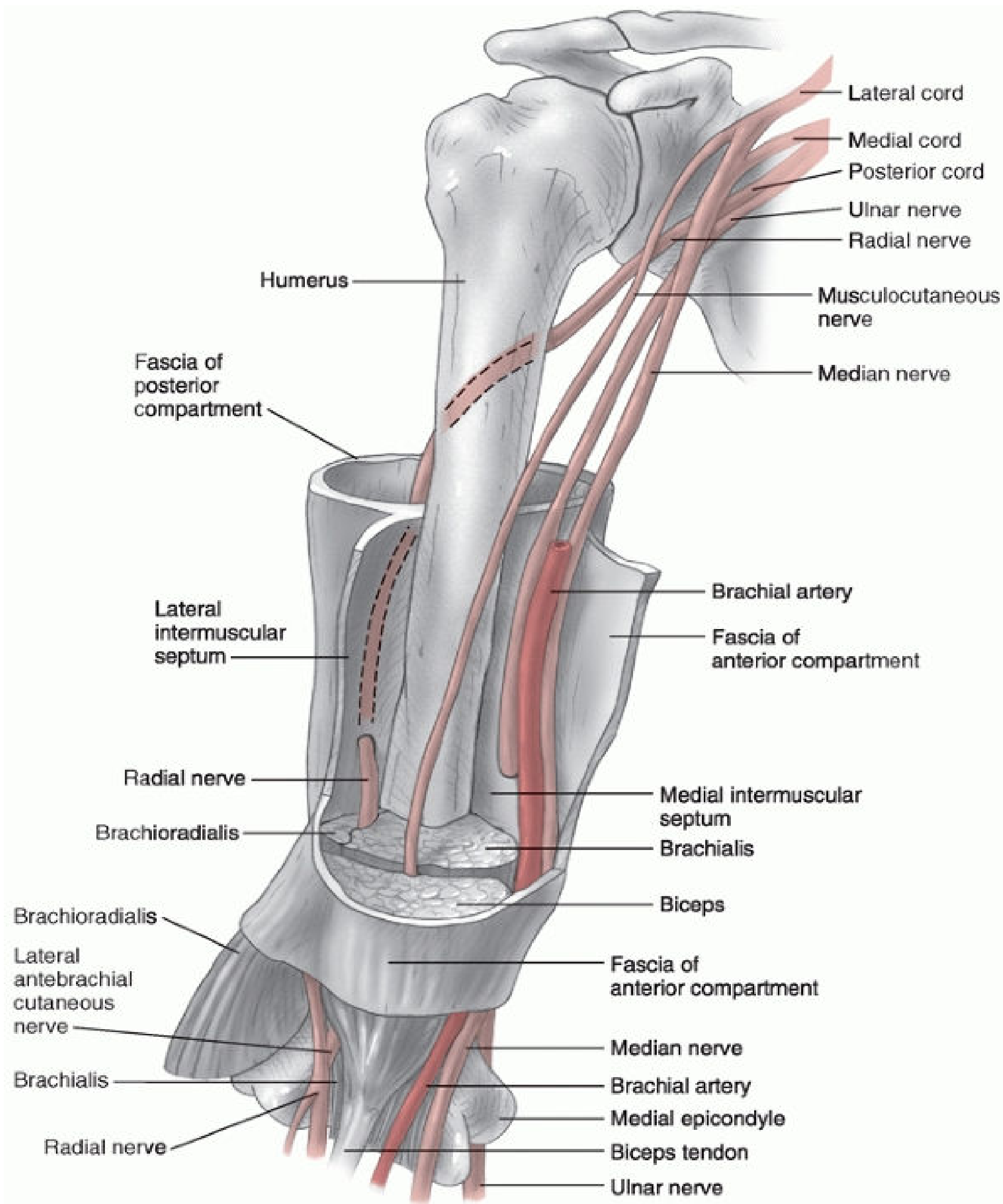


deltoid tuberosity which is present near the middle of this surface.From behind the upper part of the shaft is crossed by a broad and shallow radial groove which runs downwards and laterally across the posterior and anterolateral surfaces.

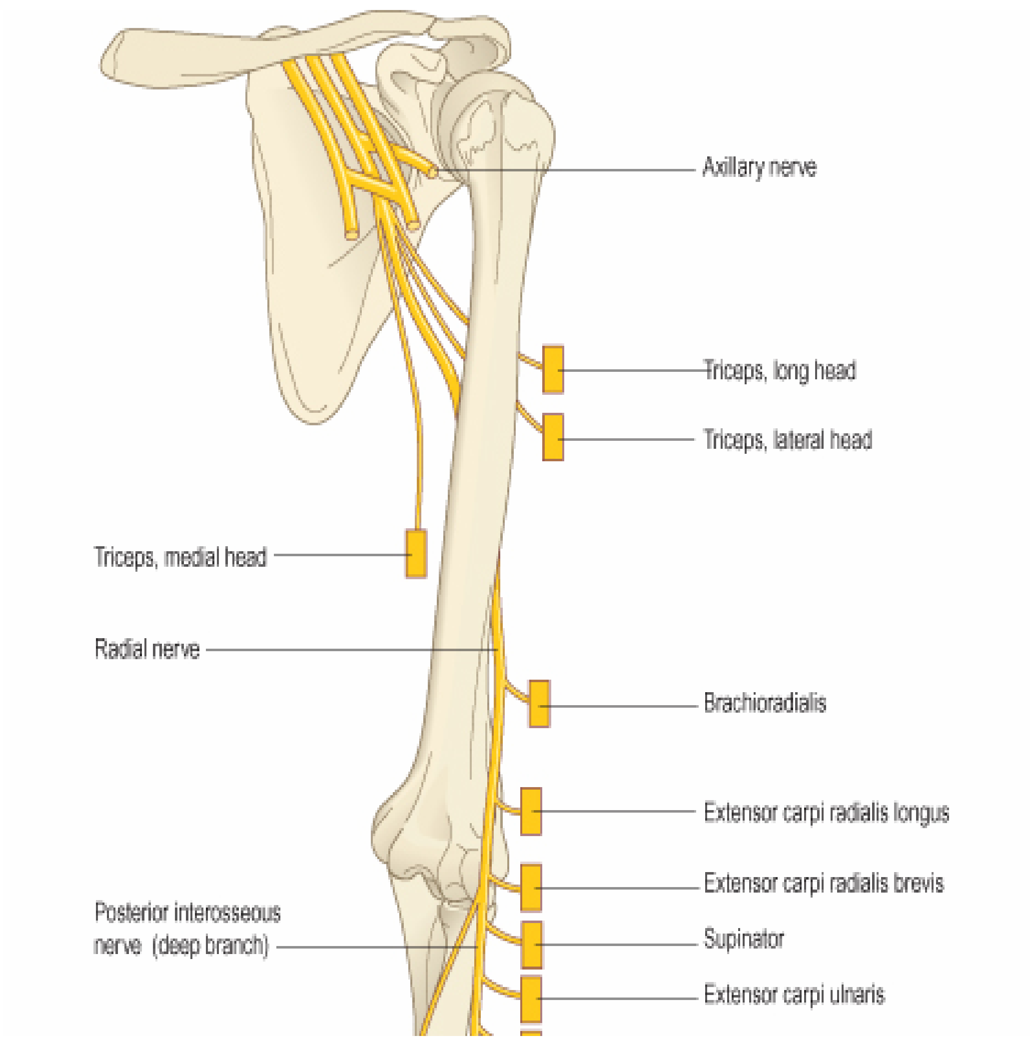
The **anteromedial surface** is bounded by the anterior and medial borders. Distal to the intertuberous sulcus a small area of the anteromedial surface is devoid of muscular attachment, but its lower half is occupied by the medial part of brachialis. Coracobrachialis is attached to a roughened strip on the middle of the medial border. The humeral head of pronator teres is attached to a narrow area close to the lowest part of the medial supracondylar ridge, and the ridge itself gives attachment to the medial intermuscular septum of the arm.

The **posterior surface** lies between the medial and lateral borders. A ridge descends obliquely and laterally across its proximal third, and gives attachment to the lateral head of triceps. Above triceps, the axillary nerve and the posterior circumflex humeral vessels wind round this aspect of the bone under cover of deltoid. Below and medial to the attachment of the lateral head of triceps, a shallow groove which contains the radial nerve and the profunda brachii vessels, runs downwards and laterally to gain the anterolateral surface of the shaft.



Lateral cord
Medial cord
Posterior cord
Ulnar nerve
Radial nerve
Humerus
Musculocutaneous nerve
Median nerve
Fascia of posterior compartment
Brachial artery
Lateral intermuscular septum
Fascia of anterior compartment
Radial nerve
Medial intermuscular septum
Brachioradialis
Brachialis
Biceps
Brachioradialis
Fascia of anterior compartment
Lateral antebrachial cutaneous nerve
Median nerve
Brachialis
Brachial artery
Medial epicondyle
Radial nerve
Biceps tendon
Ulnar nerve

COURSE OF RADIAL NERVE



The **lower end** of the humerus is irregular in shape and is also called the condyle. The lowest parts of the medial and lateral borders of the humerus form sharp ridges that are called the medial and lateral supracondylar ridges respectively.Their lower ends terminate in two prominences called the medial and lateral epicondyles.The lateral part is rounded and is called the capitulum.It articulates with the head of the radius.The medial part of the articular surface is shaped like a pulley and is called the trochlea.It articulates with the upper end (trochlear notch) of the ulna.

The anterior aspect of the lower end of the humerus shows two depressions. The depression above the capitulum is called the radial fossa and that above the trochlea is called the **Coronoid fossa**. Another depression is seen above the trochlea on the posterior aspect of the lower end.This depression is called the **Olecranon fossa**.

The muscles covering the humerus are coracobrachialis, brachialis and biceps brachii in the anterior compartment and triceps in the posterior compartment.

The Radial nerve and the Profunda brachii vessels lie in the radial groove between the attachments of the lateral and medial heads of the triceps.

## BLOOD SUPPLY OF THE HUMERUS

The normal blood supply of a long bone is best considered in terms of vascular systems (Rhinelander, 1972; 1974) according to its function [27]

• **Afferent vascular system**

The afferent vascular system comprises of arteries and arterioles carrying nutrients to bone.These include the principal nutrient artery, the metaphyseal arteries, the epiphyseal artery and the periosteal arterioles.

The vascular supply of the humeral diaphysis arises from perforating branches of the brachial artery.One or two main diaphyseal nutrient arteries enter the shaft obliquely through one or two nutrient foramina leading to nutrient canals.Their site of entry and angulation are almost constant and characteristically directed away from the epiphysis they divide into ascending and descending branches in the medullary cavity.

It is now well established that there are numerous musculo-periosteal vessels entering the bone at multiple points over its entire surface.

After maturity the three sources of blood supply to the diaphysis are

1. Nutrient artery

2. Metaphyseal arteries

These arteries enter on all sides at ligamentous attachments.

3. Periosteal arterioles

These arterioles enter at fascial attachments to supply the external third of the cortex locally.

- **Efferent vascular system**

This system comprises of the veins and venules carrying the waste products away from the bone.These include

1. Metaphyseal veins
2. Cortical venous channels from deep cortex to periosteal venules
3. Venae comitantes accompanying the nutrient artery
4. Large emissary veins which completely traverse the cortex

- **Intermediate vascular system**

The principal nutrient artery and the metaphyseal arteries carry blood from the circulation almost exclusively into the medulla. The intravascular pressure in the medulla is higher than in the periosteal area. This pressure gradient is the chief factor maintaining the blood flow in bone **centrifugally** (Brookes, 1971)[(28)] .

The basic components of the afferent vascular system, the principal nutrient artery and the metaphyseal arteries carry blood from the circulation almost exclusively into the medulla[29].

The medullary arterial supply provides circulation to the inner two-thirds of the cortex leaving the periosteal arterial supply to provide circulation to the remaining outer third of the cortex.

## Applied Anatomy

Fracture Healing:

Periosteal circulation plays a very important role in healing of fractures. Soft tissue stripping, while performing an internal fixation of a fractured bone must be kept to a minimum to encourage the participation of periosteum and its circulation in fracture healing.

## AO CLASSIFICATION [1]

**A1 Simple fracture, spiral**
- .1 proximal zone
- .2 middle zone
- .3 distal zone

**A2 Simple fracture, oblique(> or = 30°)**
- .1 proximal zone
- .2 middle zone
- .3 distal zone

**A3 Simple fracture, transverse (< 30°:)**
- .1 proximal zone
- .2 middle zone
- .3 distal zone

**B1 Wedge fracture, spiral wedge**
- .1 proximal zone
- .2 middle zone
- .3 distal zone

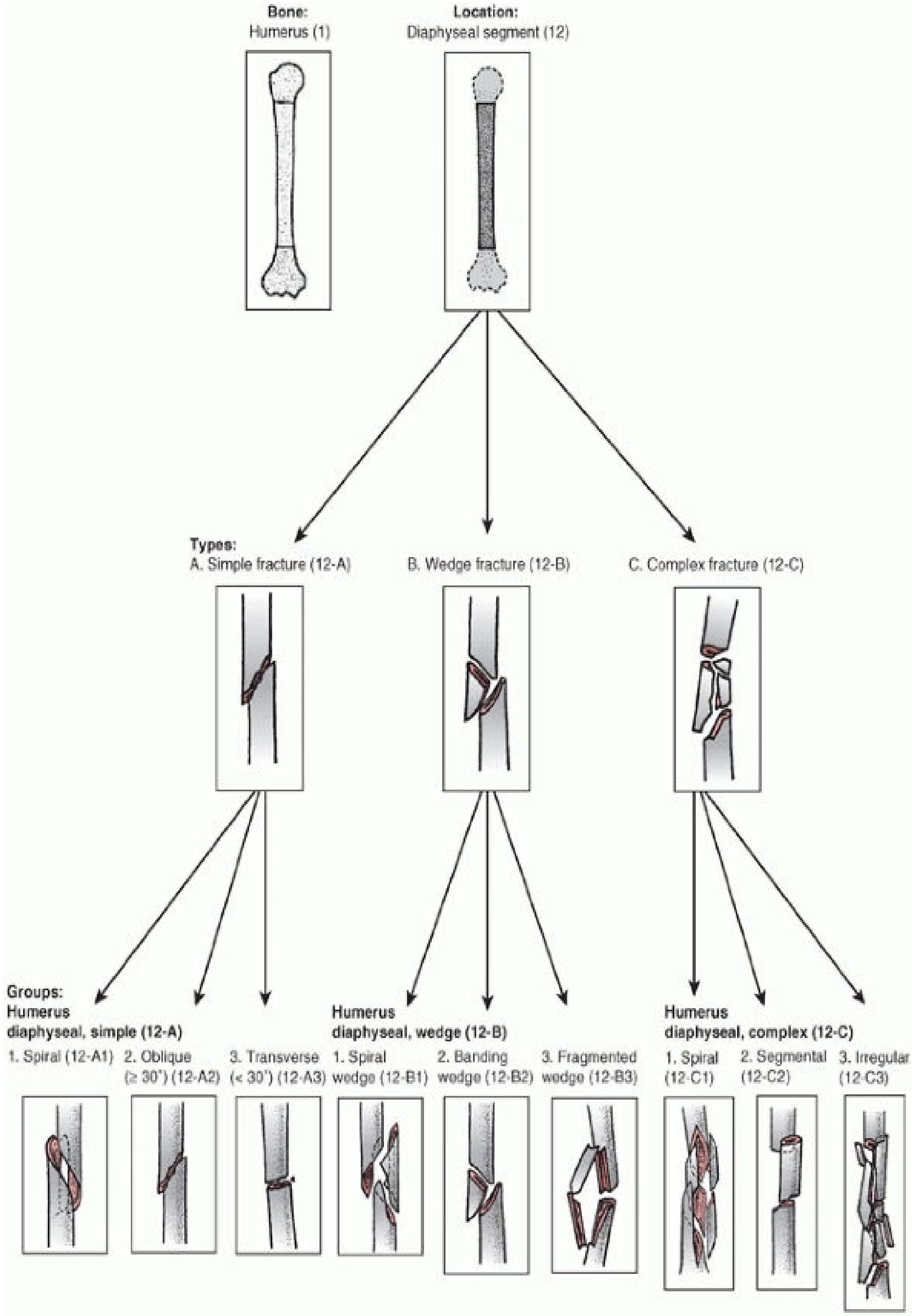
**B2 Wedge fracture, bending wedge**
- .1 proximal zone
- .2 middle zone
- .3 distal zone

**B3 Wedge fracture, fragmented wedge**
- .1 proximal zone
- .2 middle zone
- .3 distal zone

**C1 Complex fracture, spiral**
- .1 with two intermediate fragments
- .2 with three intermediate fragments
- .3 with more than three intermediate fragments

**C2 Complex fracture, segmental**
- .1 with one intermediate segmental fragment
- .2 with one intermediate segmental and additional wedge fragment(s)
- .3 with two intermediate segmental fragments

**C3 Complex fracture, irregular**
- .1 with two or three intermediate fragments
- .2 with limited shattering (< 4 cm)
- .3 with extensive shattering (> or = 4 cm)

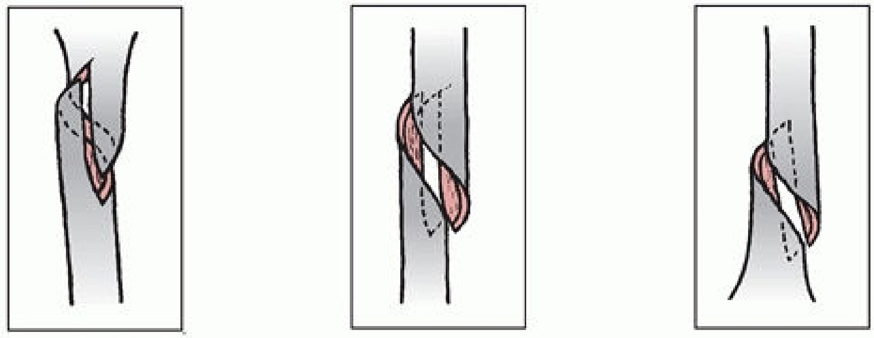


Bone:
Humerus (1)
Location:
Diaphyseal segment (12)
Types:
A. Simple fracture (12-A)
B. Wedge fracture (12-B)
C. Complex fracture (12-C)
Groups:
Humerus
diaphyseal, simple (12-A)
1. Spiral (12-A1)
2. Oblique (≥ 30°) (12-A2)
3. Transverse (< 30°) (12-A3)
Humerus
diaphyseal, wedge (12-B)
1. Spiral wedge (12-B1)
2. Banding wedge (12-B2)
3. Fragmented wedge (12-B3)
Humerus
diaphyseal, complex (12-C)
1. Spiral (12-C1)
2. Segmental (12-C2)
3. Irregular (12-C3)

**Subgroups and qualifications:**
**Humerus diaphyseal, simple, spiral (12-A1)**

1. Proximal zone (12-A1.1)
2. Middle zone (12-A1.2)
3. Distal zone (12-A1.3)

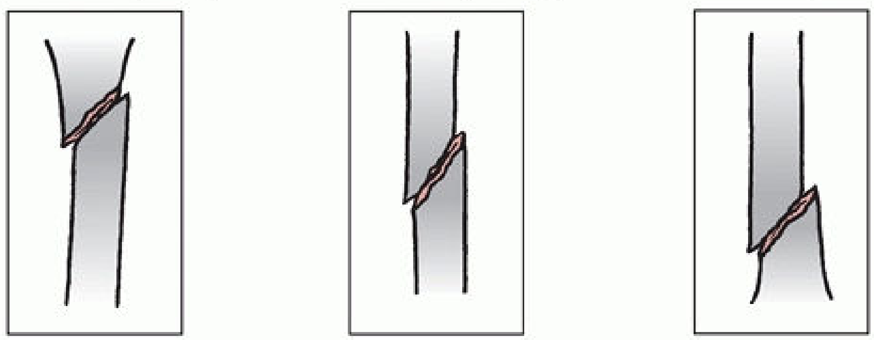
**A1**



**Humerus diaphyseal, simple, oblique (≥ 30°) (12-A2.2)**

1. Proximal zone (12-A2.1)
2. Middle zone (12-A2.2)
3. Distal zone (12-A2.3)

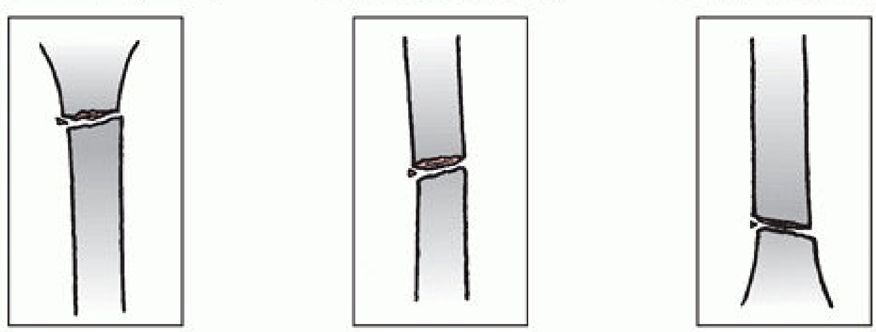
**A2**

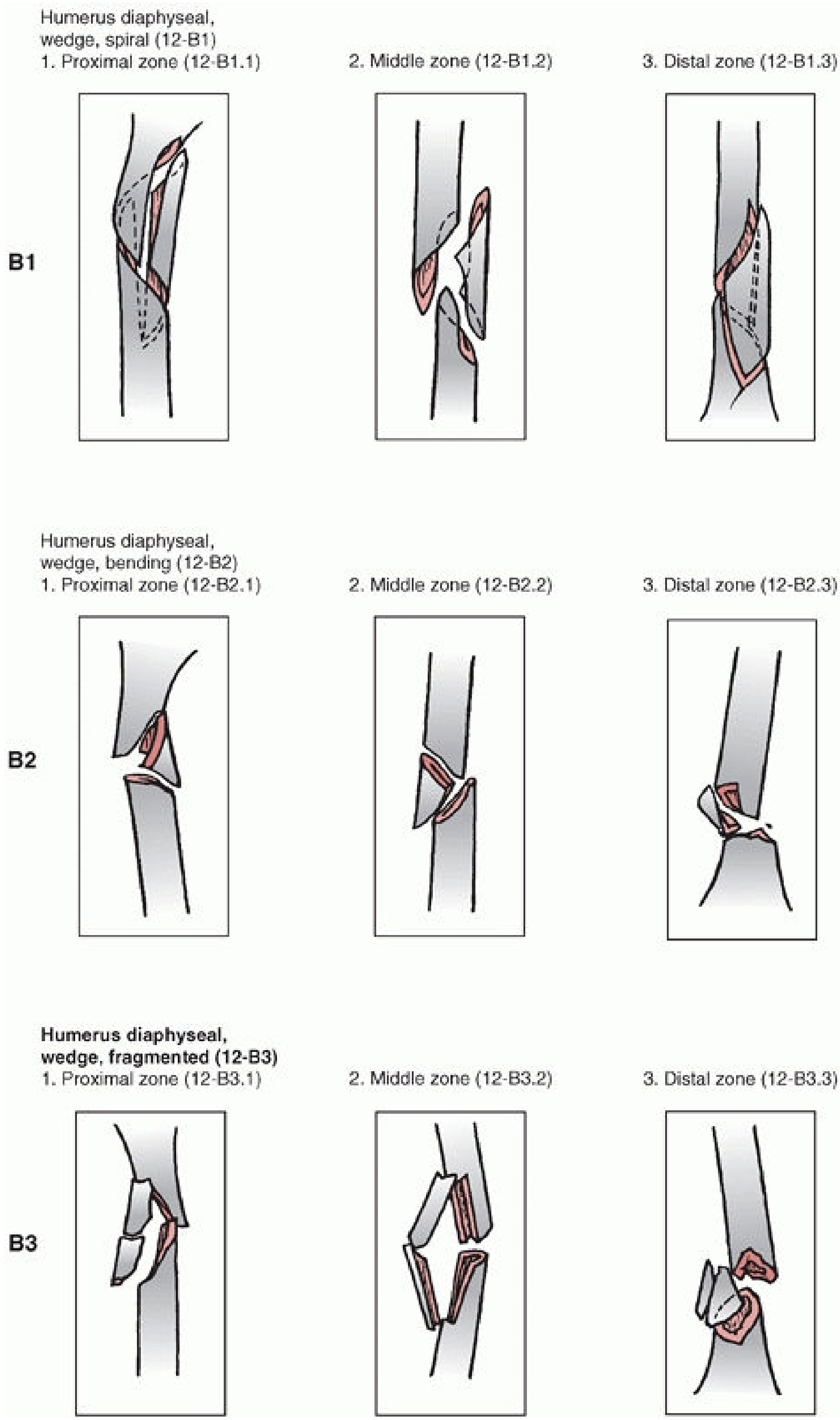


**Humerus diaphyseal, simple, transverse (< 30°) (12-A3)**

1. Proximal zone (12-A3.1)
2. Middle zone (12-A3.2)
3. Distal zone (12-A3.3)

**A1**




Humerus diaphyseal,
wedge, spiral (12-B1)
1. Proximal zone (12-B1.1)
2. Middle zone (12-B1.2)
3. Distal zone (12-B1.3)
B1
Humerus diaphyseal,
wedge, bending (12-B2)
1. Proximal zone (12-B2.1)
2. Middle zone (12-B2.2)
3. Distal zone (12-B2.3)
B2
Humerus diaphyseal,
wedge, fragmented (12-B3)
1. Proximal zone (12-B3.1)
2. Middle zone (12-B3.2)
3. Distal zone (12-B3.3)
B3

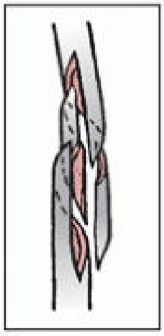
**Humerus diaphyseal, complex, spiral (12-C1)**
(1) Pure diaphyseal
(2) Proximal diaphylo-metaphyseal
(3) Distal diaphyslo-metaphyseal

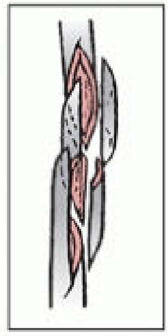
**1. With 2 intermediate fragments (12 -C1.1)**

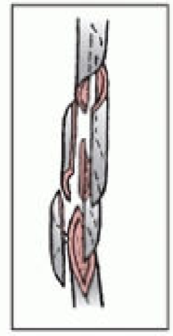
**2. With 3 intermediate fragments (12-C1.2)**

**3. With more than 3 intermediate fragments (12-C1.3)**

**C1**







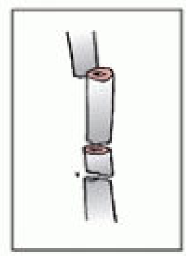
**Humerus, diaphyseal, complex segmental (12-C2)**

**1. With 1 intermediate segmental fragment (12-C2.1)**
(1) Pure diaphyseal
(2) Proximal diaphyslo-metaphyseal
(3) Distal diaphyslo-metaphyseal
(4) Oblique lines
(5) Transverse and oblique lines

**2. With 1 intermediate segmental and additional wedge fragments (12-C2.2)**
(1) Pure diaphyseal
(2) Proximal diaphyslo-metaphyseal
(3) Distal diaphyslo-metaphyseal
(4) Distal wedge
(5) Two wedges, proximal and distal

**3. With 2 intermediate segmental fragments (12-C2.3)**
(1) Pure diaphyseal
(2) Proximal diaphyslo-metaphyseal
(3) Distal diaphyslo-metaphyseal

**C2**



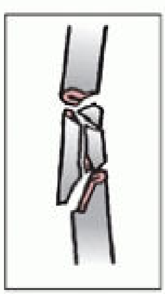
**Humerus,diaphyseal, complex irregular (12-C3)**

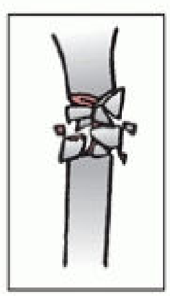
**1. With 2 or 3 intermediate fragments (12-C3.1)**
(1) 2 main intermediate fragments
(2) 3 main intermediate fragments

**2. With limited shattering (< 4 cm) (12-C3.2)**
(1) Proximal zone
(2) Middle zone
(3) Distal zone

**3. With extensive shattering (> 4 cm) (12-C3.3)**
(1) Pure diaphyseal
(2) Proximal diaphyslo-metaphyseal
(3) Distal diaphyslo-metaphyseal

**C3**





## EVOLUTION OF INTRAMEDULLARY NAILS

In the beginning of the 20th century, **Ernest Hey Groves (England)** already used specially designed three- or four-edged intramedullary nails for the fixation of diaphyseal long bone fractures.

**Smith – Petersen** introduced a nail in 1920's to fix subcapital femoral fractures

In 1940**, Lambrinudi** suggested the placement of strong wires and thin metal sticks through the medullary canal. This method was later upgraded by the Rush brothers.

In 1950's ,two important techniques were developed. In 1942**,Fischer** reported the use of intramedullary reamers to increase the contact area between the nail and the host bone**. Kuntscher**[30] introduced the flexible reamers and they believed that reaming along with larger diameter nail would enhance the stability of fractures by increasing the contact area. He also felt that although intramedullary vascular supply was obliterated by this the periosteum and surrounding tissues would promote adequate bone formation for healing. In 1960's cephallomedullary nails were introduced highlighted by the development of the Zickel nail which contained a hole in the proximal portion of the nail for head and neck.

In the 1990s, the major advancements came with the expansion of indications for unreamed and reamed intramedullary nailing.

## EFFECTS OF REAMING

Reaming has a significant biologic and mechanical impact on the physiology of fracture healing. Intramedullary reaming causes **destruction of the contents of the marrow Cavity** (Blood vessels and marrow). The medullary canal is irregular in both longitudinal and cross sections. For a stable intramedullary fixation a firm fit is needed.

The process of reaming is for centralizing the nail and also produces a larger contact area between the nail and bone thereby increases the stability of fixation[31]. Reaming allows insertion of larger diameter , stronger nail and reaming can **stimulate fracture healing** by providing a source of autologous bone graft from the reamed particles at the fracture site.

Outcome studies consistently show that reaming potentiates the healing response with intramedullary fixation of long-bone fractures. Recent laboratory studies implicate alterations in cortical blood flow patterns and **the osteogenic potential of reaming debris** as critical components of this process.

## COMPLICATIONS

**Thermal necrosis is a rare** [32] but commonly referenced complication of reaming. The risks of heat-induced cortical damage can be minimized by sequential reaming with sharp instruments and by reaming with instruments that are sized appropriately to fit the intramedullary canal. Reaming results in increased intramedullary pressure and secondary embolization of marrow elements to the pulmonary system.

Points to reduce the complication while reaming

1. Avoid reamers with blunt flutes.
2. Always start with the end cutting reamer
3. Reamers should be with deep flutes to facilitate passage of medullary contents
4. Advancement of the reamer must be slow with reamer rotating at full speed.
5. Distal vent can be used to lower the medullary pressure.

## BIOMECHANICS OF IM NAILING

The intramedullary nail or rod is commonly used for long-bone fracture fixation particularly diaphyseal and selected metaphyseal fractures. These implants are introduced into the bone remote to the fracture site and share compressive, bending, and torsional loads with the surrounding osseous structures. Intramedullary nails function as **internal splints** [(33)] that allow for secondary fracture healing, A nail is subject to fatigue and can eventually break if bone healing does not occur.

The basic principle of Intramedullary nailing is “Dynamic Osteosynthesis”[(34)]

**Intrinsic characteristics** that affect nail biomechanics include its material properties, cross-sectional shape, anterior bow, and diameter.

**Extrinsic factors**, such as reaming of the medullary canal, fracture stability (comminution), and the use and location of locking bolts also affect fixation biomechanics.

Although reaming and the insertion of intramedullary nails can have early deleterious effects on endosteal and cortical blood flow, canal reaming appears to have several positive effects on the fracture site, such as increasing extraosseous circulation, which is important for bone healing.

## EVOLUTION OF PLATES [35]

Metal fixation for internal fixation of fractures have been used for more than 100 years.**Lane** first introduced a metal plate in 1895 for internal fixation which was eventually abandoned owing to problems with corrosion.

**Lambotte** in 1902 and Sherman in 1912 introduced their versions of plates which had improvements in metallurgical formulation which increased corrosive resistance but both were eventually abandoned as a result of their insufficient strength.

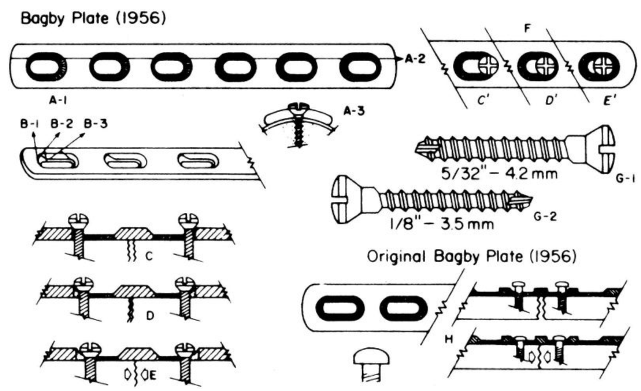
Lambotte plate

The next important development in fracture plate design was initiated by **Eggers** in 1948 with two long slots which allowed screw heads to slide.The use of this plate was limited by its structural weakness and the resultant instability of its fixation.

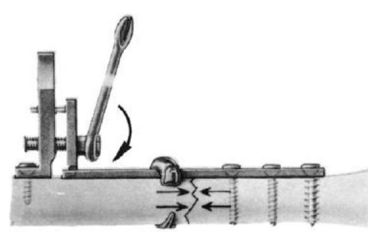
**Danis** in 1949 recognized the need for compression between the fracture fragments and introduced a plate he called the **coapteur**, which suppressed the interfragmentary motion and increased the stability.

Danis plate

In 1958 **Bagby and Janes** designed a plate with oval holes which allowed interfragmentary compression while tightening the screws.

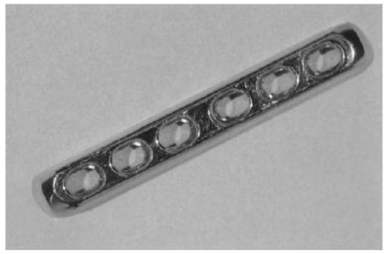



**Muller** et al. permitted interfragmentary compression by using a tensioner that was temporarily anchored to the bone and the plate.



Tensioner device

**Dynamic Compression Plate (DCP)** has specially designed oval holes similar to Bagby and Janes invention to compress bony fragments during screw tightening.



Dynamic Compression Plate

**Advantages**:

1. Low incidence of malunion
2. Stable internal fixation
3. No need for external immobilization
4. Early mobilization of neighbouring joints

The **Swiss group** developed a plate design to reduce the plate's interference with cortical perfusion and decrease cortical porosis which is called as Limited Contact – Dynamic Compression Plate **(LC-DCP).**

The concept of biological osteosynthesis led to the development of the Point-contact fixator **(PC-FIX),**which abandoned interfragmentary compression and bicortical fixation.

## CLASSIFICATION OF PLATES

A bone plate has two mechanical functions[36].

1. Transmits forces from one end of the bone to the other, bypassing and thus protecting the area of fractures.

2. Holds the fractures ends maintaining the proper alignment throughout the healing process.

Regardless of their length, thickness, geometry and configuration, all plates are classified into

1. Neutralization plate
2. Compression plate
3. Butress plate
4. Condylar plate

### 1. **Neutralization Plate:**

A Neutralization plate acts as a "bridge". Its main function is to act as a mechanical link between the healthy segments of bone above and below the fracture.It does not produce any compression at the fracture site.

The most common clinical application of this plate is to protect the screw fixation of a short oblique fracture or butterfly fragment or for the fixation of a segmental bone defect in combination with bone grafting.

2. **Compression Plate:**

A compression plate produces a locking force across a fracture site to which it is applied.The effect occurs according to Newton's third law.The direction of the force is parallel to the plate.

Compression can be Static or Dynamic.A plate applied under tension produces static compression at a fracture site.This compression is constant when the limb is at rest or is functioning. Dynamic compression is a phenomenon by which the plate can transfer or modify functional physiological forces into compressive forces at the fracture site.When functional activity begins the physiological forces which are normally destabilizing for the fracture are converted to a stabilizing and active force by the same plate which now acts as a tension band.

3. **Buttress Plate:**

The mechanical function of this plate is to strengthen (buttress) the weakened area of the cortex.It prevents the bone from collapsing during the healing process. This plate applies a force to the bone which is perpendicular to the flat surface of the plate.It is mainly used to maintain the bone length or to support the depressed fracture fragments.It is commonly used in fixing epiphyseal and metaphyseal fractures.

4. **Condylar Plate:**

Its main application has been in the treatment of intra-articular distal femoral fractures.It has two mechanical functions.

1. It maintains the reduction of the major intra-articular fragments thus restoring the anatomy of the joint surface.
2. Rigidly fixes the metaphyseal components to the diaphyseal shaft.

## PRINCIPLE OF ABSOLUTE STABILITY USING PLATES

Absolute stability of plated fractures requires anatomical reduction and interfragmentary compression,which can be established by lag screws,axial compression by plate or both. In most individuals, the humerus requires six cortices of screw purchase on each side[37].Static compression between two fragments is maintained over several weeks and does not enhance bone resorption or necrosis.Fracture fragment interdigitation and compression reduces interfragmentary motion to nearly zero and allows for direct bony remodelling of the fracture (primary bone healing without callus).

Compression must sufficiently neutralize all forces (bending, tension,shear, and rotation) along the whole cross section of a fracture to achieve absolute stability.

There are four ways of achieving interfragmentary compression with a plate : [38]

1. compression with the dynamic compression unit in a plate
2. compression by contouring (overbending) the plate
3. compression by additional lag screws through plate holes
4. compression with the articulated tension device

## GENERAL PRINCIPLES OF PLATE FIXATION

Successful use of a bone plate depends on the properties of the plate,the screws,the bone and on the correct application of biomechanical principles.

### Plate related factors

The strength of a plate depends on

the thickness of the plate and

the stiffness of the material which should be close to the bone

### Screw related factors

The effectiveness of the screw depends on the

Design of the thread

Screw head

A minimum of 6 cortices on each side of the fracture is necessary for a rigid fixation in humerus

Strength of the plate fixation depends on the holding power of the screws.

**Bone related factors:**

The health of the bone is an important factor as the holding power of the screw is dependent on the elastic force provided by the bone.

**Construct related factors**

The strength of the construct will depend on the direction of the load and the position of the plate. The plate applied on the tension side of the bone is a strong construct. It becomes strongest when two plates are applied at right angles to each other.

The strength of the reconstructed bone depends on :

1. Strength of the plate and screw – design,dimension and material and purchase
2. Configuration of the fracture – comminution and placement of plate
3. Properties of the plate-bone construct – working length and load sharing

# SURGICAL APPROACHES[39]

## ANTEROLATERAL APPROACH

Position of the patient

The patient is placed supine on the operating table with the arm lying on an armboard and abducted about 60°.

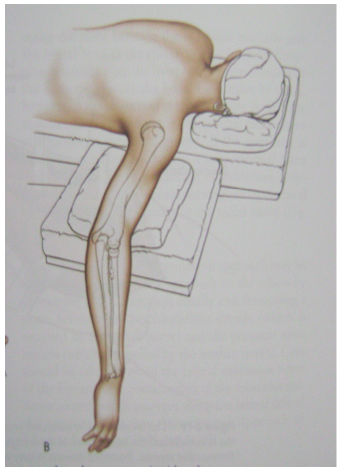
Incision

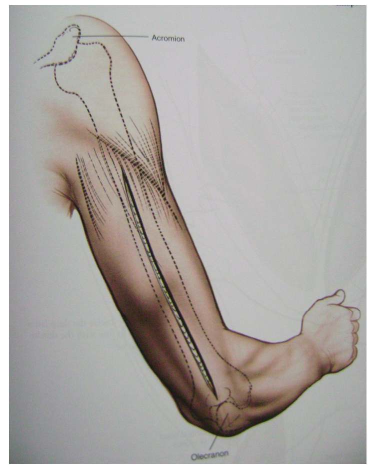
A curved longitudinal incision over the lateral border of the biceps starting about 10 cms proximal to the flexion crease of the elbow.

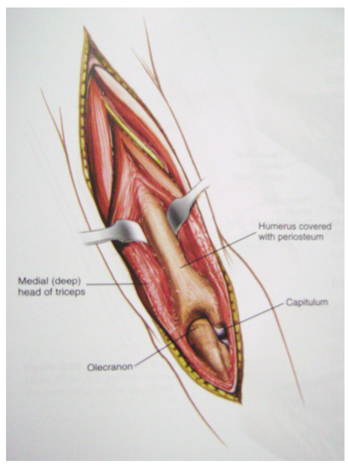
Dissection

There is no internervous plane.Superficially, the biceps is retracted medially to reveal the brachialis and the brachioradialis and an intermuscular plane is developed between them.Radial nerve is identified between the muscles at the level of the elbow joint.It is retracted medially and the deep dissection is done by incising the lateral border of the brachialis and by lifting it off by subperiosteal dissection.

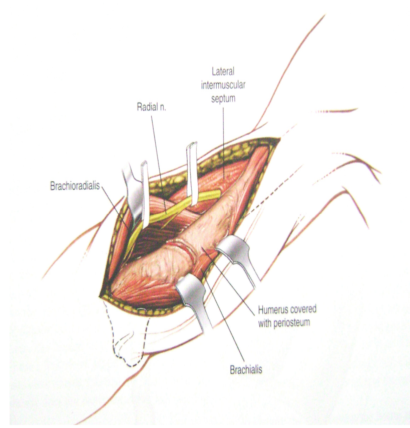
## POSTERIOR APPROACH






## ANTERO LATERAL APPROACH

## POSTERIOR APPROACH

Position of the patient

The patient is placed either in lateral position with the affected side uppermost or in prone position with the arm 90° and the elbow allowed to bend and the forearm to hang over the side of the table.

Incision

A longitudinal incision in the midline of the posterior aspect of the arm, from 8 cms below the acromion to the olecranon fossa.

Dissection

There is no true internervous plane. Superficially to identify the gap between the lateral and long head of triceps,above the level where they fuse to form a common tendon . Proximally continue blunt dissection between the two heads and distally it needs sharp dissection along the line of incision.Deeply, the medial head of triceps is incised in the midline, down to the periosteum and strip the muscle by epi-periosteal dissection.

# MATERIALS AND METHODS

This is a prospective comparative study of 22 patients with humeral shaft fractures treated with Intramedullary interlocking nailing and Plate osteosynthesis done in the Department of Orthopaedics,Government Kilpauk Medical College Hospital from April 2009 to May 2010.

## INCLUSION CRITERIA

- Acute fractures of humeral shaft
- Patients aged above 18 years
- Fractures 2cm below surgical neck and 3 cm above olecranon fossa
- Multiple injuries
- Neurovascular involvement
- Osteoporotic bone
- Angulation more than 15 degrees
- Non compliance in conservative treatment

## EXCLUSION CRITERIA

- Open physis
- Age less than 18 years
- Fractures involving proximal 2 cms and distal 3 cms of the humeral diaphysis

## MANAGEMENT

All cases are initially assessed for head injury and other associated injuries and resuscitated .Initial management was done with U – slab till the patient is fit for surgery.

## IMPLANT USED FOR INTERLOCKING NAILING:

The nail used in our study is Sharma nail. They are available in diameters of 6.0mm that are non cannulated solid nails and the 7.0mm cannulated nails. They can be inserted over 2.4 mm thick guide wire.The nails are available in various lengths starting from 160 mm onwards at increments of 10mm . The proximal locking is provided from lateral to medial direction. The distal locking are 2 in number and both are static for the 6.0mm solid nails and the proximal being dynamic and distal static for the 7.0mm cannulated nails. The distal locking are in the anteroposterior direction. The nail size is measured with the full length x-ray from tip of greater tuberosity to 3cms above the proximal tip of olecranon fossa.Clinically it is measured by subtracting 5 cms from the tip of acromian to the lateral epicondyle of humerus. The best method is by a scanogram . It is a must to have all nail sizes and appropriate instrumentation .It is mandatory to have the C- arm image intensifier and a good technician.  Bone Graft was done in 1 patient where fracture was reduced by open method.

IMPLANTS USED FOR INTERLOCKING NAILING

# SURGICAL TECHNIQUE OF IM NAILING

## ANTEGRADE HUMERUS NAILING BY CLOSED METHOD

POSITION OF THE PATIENT

The patient is positioned supine on a fracture table with a sand bag under the shoulder and the whole upper limb is prepared and drapped to keep the limb free.

ANAESTHESIA

General anaesthesia or Regional block

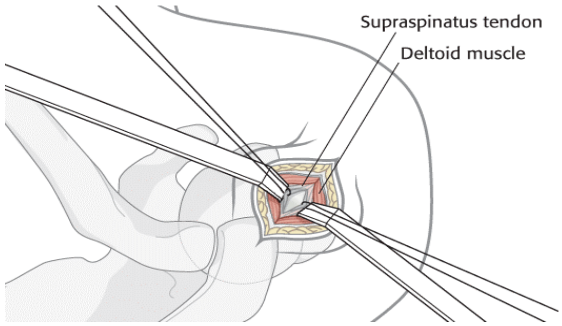
APPROACH

Through Lateral Deltoid Splitting approach with the image intensifier the entry point is made just medial to the greater tuberosity and in the area at junction between the articular surface of the head and greater tuberosity with a k-wire and passed into the medullary canal.

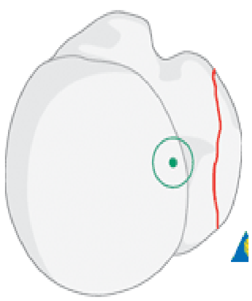
After splitting the deltoid , the Rotator cuff is exposed and split at the tendon of the supraspinatus. The entry point reamer is used over the k-wire and is enlarged.45 cms guide wire is introduced through the entry point and is passed into the distal fragment after reducing the fracture closed and under

INTERLOCKING NAILING OF HUMERUS

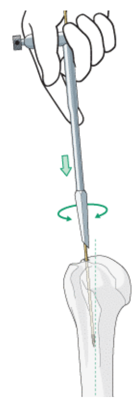
DELTOID SPLITTING APPROACH



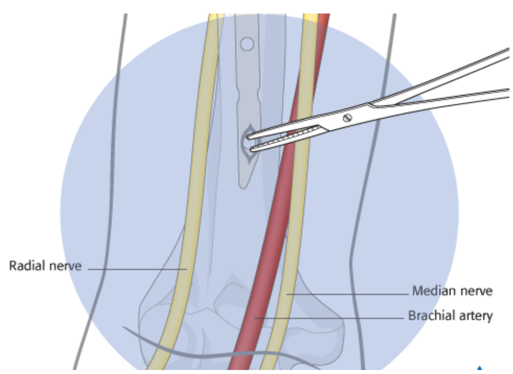

ENTRY POINT



REAMING



DISTAL LOCKING



the guidance of C-arm image intensifier.Progressive reaming was done over the guide wire upto 1 mm more than the desired nail size.

**Nail Insertion**

The appropriate nail is mounted on the zig and inserted through the guide wire. The nail size should be carefully selected because over size nail may end up splintering the distal fragment.The nail is pushed to a level where the nail is not protruding out through the articular surface of the proximal humerus.

**Distal Locking**

The size of nail are the 7mm cannulated nails.The distal locking for the 7mm cannulated nail was 4.5 mm self tapping locking screws for which 3.00mm drillbits were used. The distal locking are antero-posterior locking. Under image guidance a stab incision is made at the anterior aspect of forearm , the bicep and brachialis is split to expose the surface of the bone. Under image guidance appropriate drill bit is used and the distal screws are inserted.

**Proximal Locking**

This is done using the proximal jig that is mounted with the nail. Care must be used to avoid the axillary nerve. The proximal locking are in the medio-lateral plane.

**OPEN REDUCTION OF FRACTURES**

This technique was used for fixing old fractures . Fracture site is exposed by anterolateral approach. Skin incision is made in the groove between the prominences of biceps brachii and deltoid. Cephalic vein is identified and ligated. Plane is created between the muscle bulk of biceps and deltoid. Brachialis is split in the middle to expose the fracture site. Fracture site is exposed and freshened. Bone grafting may be placed to promote fracture union.

**Post – operative protocol**:

Immediately after surgery the limb is supported with an arm sling.

Wound inspection was done on $2^{nd}$ post operative day

Suture removal on $12^{th}$ post op day

In cases of nailing ,active elbow and shoulder excercises started on $3^{rd}$ day under the supervision of the physiotherapist.

## SURGICAL TECHNIQUE OF PLATE OSTEOSYNTHESIS

### IMPLANTS USED

The most commonly used plate for fixation of humeral shaft fractures is the broad, 4.5-mm dynamic compression plate, occasionally, a narrow, 4.5-mm, DCP is used for smaller bones. For spiral or oblique fractures, the ideal construct consists of a lag screw with a neutralization plate, whereas transverse fractures are ideally suited for a compression plating technique. Bone Graft was done in 3 cases.

### PROCEDURE [40]

ANAESTHESIA :

General or Regional Block

POSITION OF THE PATIENT:

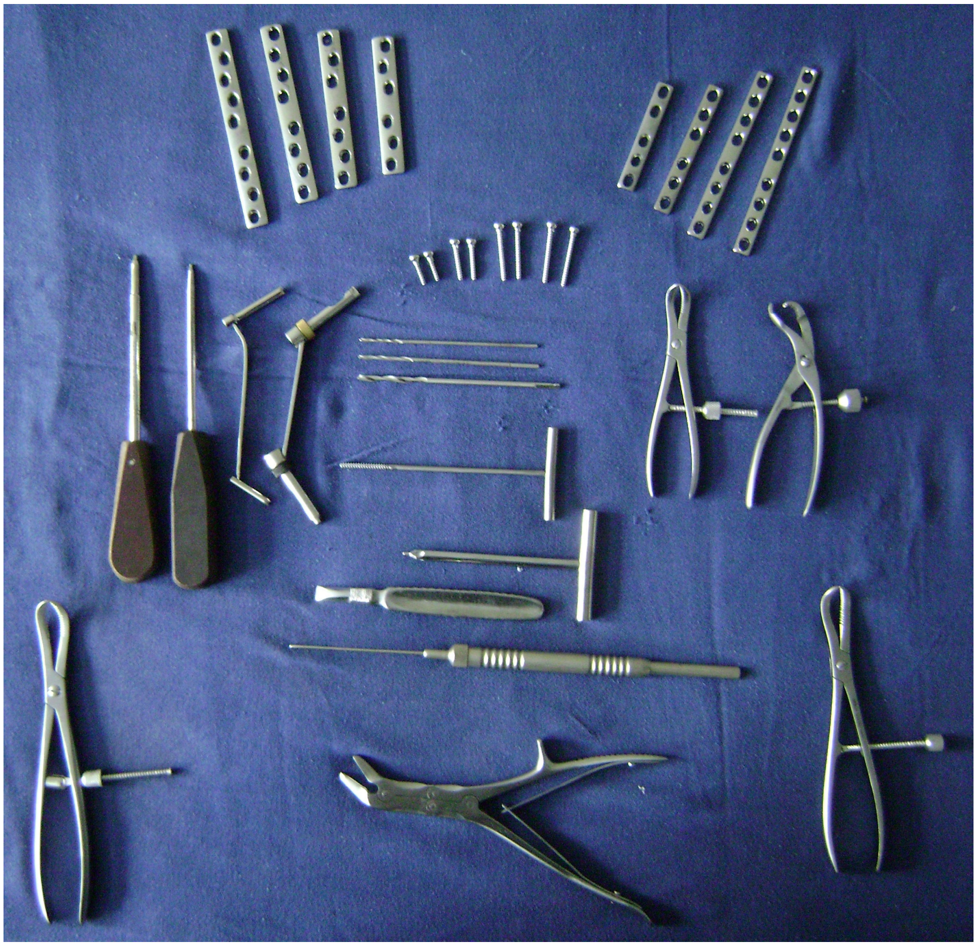
Lateral position with elbow flexed over a pillow and forearm hanging by the side.

APPROACH

POSTERIOR APPROACH

Through posterior approach incision was made in midline upto the tip of

IMPLANTS USED FOR PLATE OSTEOSYNTHESIS



olecranon in line with the humerus.The dissection is carried down to the triceps fascia and the fascia is incised. The radial nerve is identified and freed proximally and distally to allow for mobilization.The triceps is incised off the periosteum and the fracture site is exposed.After the fracture ends are freshened, the fragments are reduced and held with bone clamps or with a lag screw.

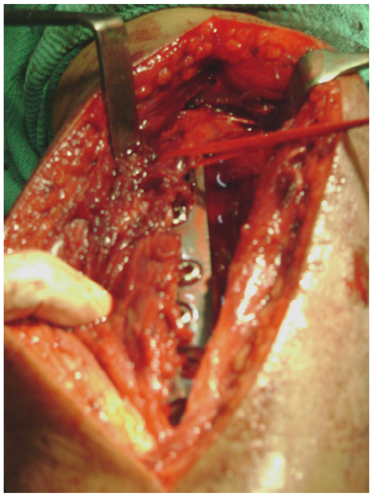
Then it is fixed with 4.5mm broad or narrow DCP in neutralization or compression mode.

**Post – Operative Protocol:**

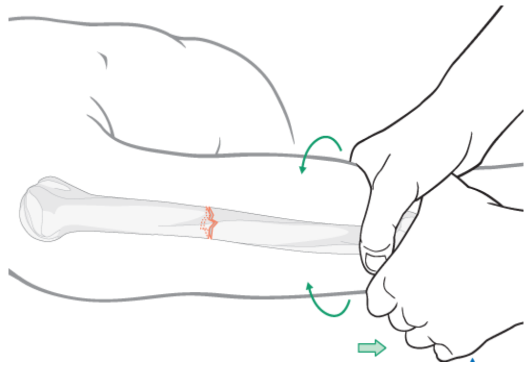
Wound inspection done on 2$^{nd}$ post op day. Suture removal done on 12$^{th}$ day In cases of Plating , active shoulder and elbow started on 5$^{th}$ to 6$^{th}$ day once the pain level decreases under physiotherapist guidance and tolerability of the patient.

# PLATE OSTEOSYNTHESIS

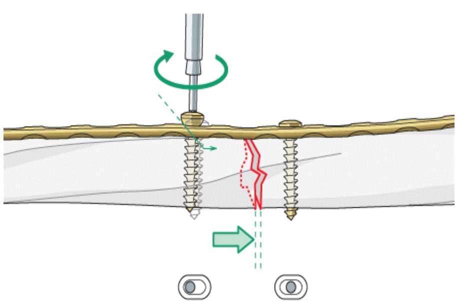
POSTERIOR APPROACH



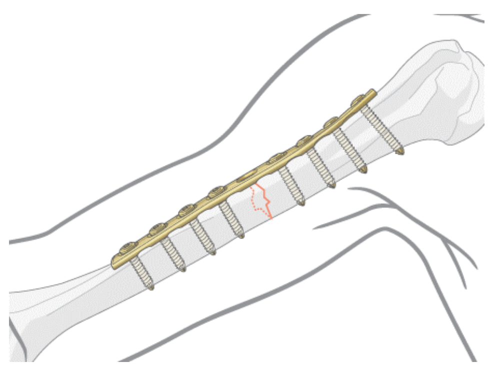
FRACTURE REDUCTION



COMPRESSION SCREW



AFTER FIXATION



## CASE 1

| | | |
|---|---|---|
| Name | : | ESTHER |
| Age/Sex | : | 45/F |
| Mode of Injury | : | Fall |
| Extremity | : | Right |
| Associated Injury | : | None |
| Type of Fracture ( AO) | : | A |
| Time Interval between Injury and surgery | : | 18 days |
| Nail size | : | 7×240 mm |
| Reduction | : | Closed |
| Post-op period | : | Uneventful |
| Mobilisation started | : | 3rd day |
| Time of union | : | 20 weeks |
| Range of Movements | : | Full |
| Complications | : | Nil |
| Rodriguez-Merchan Criteria | : | Excellent |

CASE 1

PRE-OP

4 MONTHS

6 MONTHS

**CASE 1**

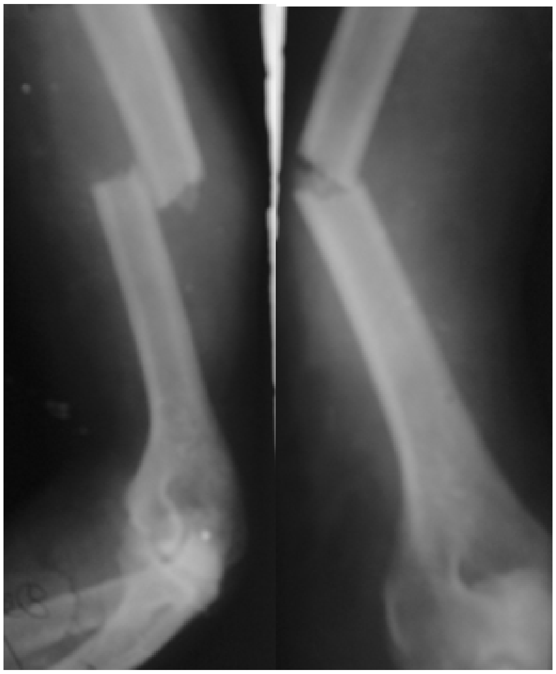
6 MONTHS FOLLOW UP

## CASE 2

| | | |
|---|---|---|
| Name | : | Srinivasan |
| Age/Sex | : | 65/M |
| Mode of Injury | : | Fall |
| Side Involved | : | Left |
| Associated Injury | : | Radial Nerve Injury |
| Fracture Type (AO) | : | A |
| Time Interval between Injury and surgery | : | 15 days |
| Nail size | : | 7×200 mm |
| Reduction | : | Closed |
| Post-op period | : | Uneventful |
| Mobilisation started | : | $3^{rd}$ day |
| Time of union | : | 16 weeks |
| Range of Movements | : | Full |
| Complications | : | Nil |
| Rodriguez-Merchan Criteria | : | Excellent |

**CASE 2**

PRE OP



14 WEEKS

6 MONTHS

**CASE 2**

6 MONTHS FOLLOW UP

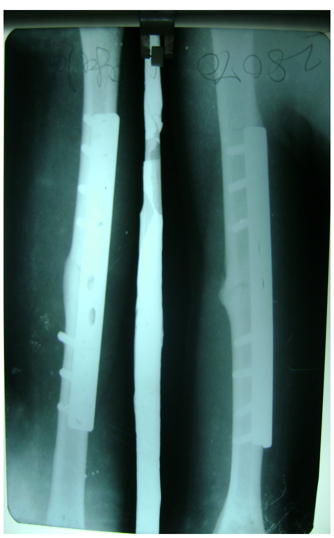
## CASE 1

| | | |
|---|---|---|
| Name | : | VijayaKumar |
| Age/Sex | : | 23/M |
| Mode of Injury | : | RTA |
| Side Involved | : | Right |
| Associated Injury | : | None |
| Fracture Type | : | A |
| Time Interval between Injury and surgery | : | 7 days |
| Plate Used | : | 10 holed Broad Dcp |
| Bone Graft Used | : | No |
| Post-op period | : | Uneventful |
| Mobilisation started | : | $5^{th}$ day |
| Time of union | : | 14 weeks |
| Range of Movements | : | Full |
| Complications | : | Nil |
| Rodriguez-Merchan Criteria | : | Excellent |

CASE 1

PRE OP


IMM. POST OP



6 MONTHS

1 YEAR

**CASE 1**

1 YEAR FOLLOW UP

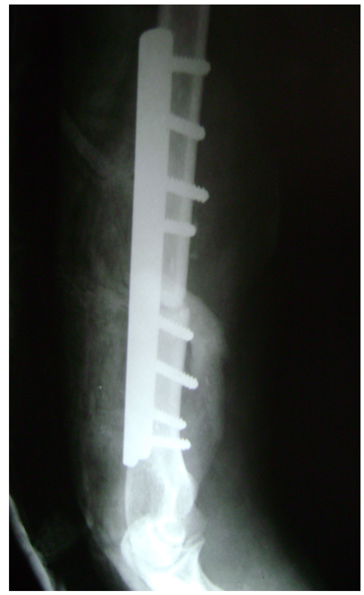
## CASE 2

| | | |
|---|---|---|
| Name | : | Vinoth Kumar |
| Age/Sex | : | 21/M |
| Mode of Injury | : | RTA |
| Side Involved | : | Right |
| Associated Injury | : | None |
| Fracture Type | : | B |
| Time Interval between Injury and surgery | : | 6 days |
| Plate Used | : | 8 Holed Narrow DCP |
| Bone Graft | : | No |
| Post-op period | : | Uneventful |
| Mobilisation started | : | 5th day |
| Time of union | : | 16 weeks |
| Range of Movements | : | Full |
| Complications | : | Nil |
| Rodriguez-Merchan Criteria | : | Excellent |

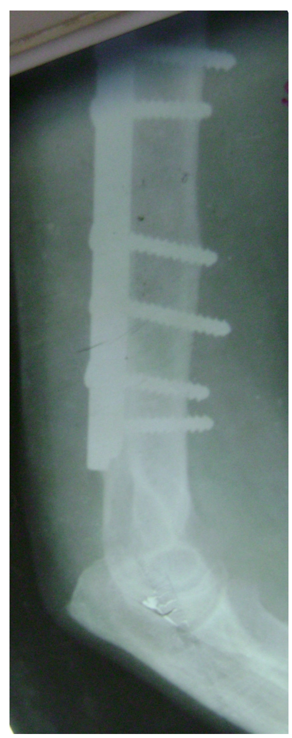
CASE 2

PRE OP

IMM. POST OP

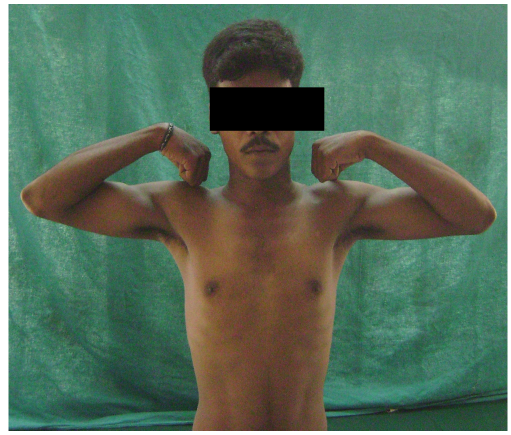


12 WEEKS



5 MONTHS

**CASE 2**



5 MONTHS FOLLOW UP

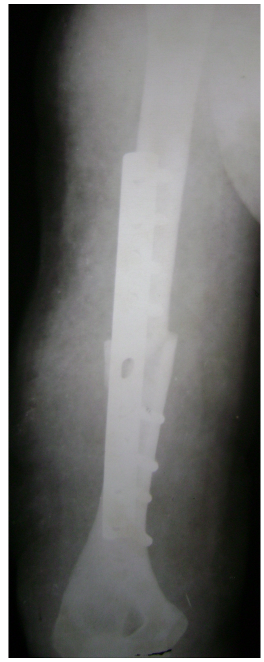
## CASE 3

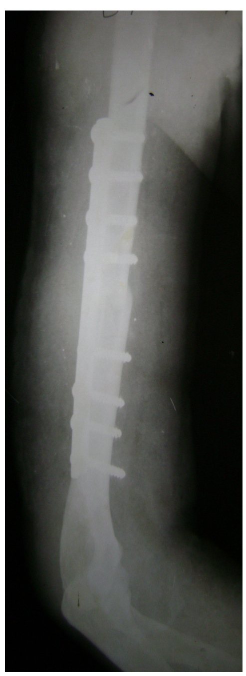
| | | |
|---|---|---|
| Name | : | Thirugnanam |
| Age/Sex | : | 45/M |
| Mode of Injury | : | Fall |
| Side Involved | : | Right |
| Associated Injury | : | None |
| Fracture Type | : | B |
| Time Interval between Injury and surgery | : | 24 days |
| Plate Used | : | 10 Holed Broad DCP |
| Bone Graft | : | Yes |
| Post-op period | : | Uneventful |
| Mobilisation started | : | $7^{th}$ day |
| Time of union | : | 18 weeks |
| Range of Movements | : | Full |
| Complications | : | Nil |
| Rodriguez-Merchan Criteria | : | Excellent |

**CASE 3**

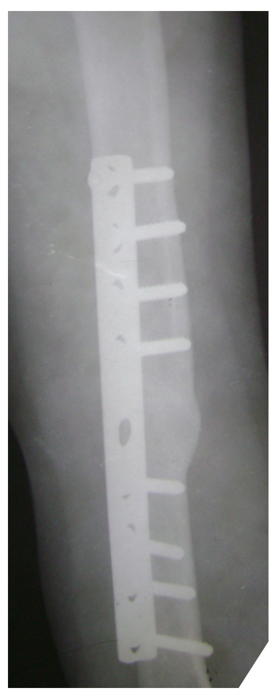
PRE OP

IMM. POST OP





3 MONTHS



6 MONTHS

CASE 3

6 MONTHS FOLLOW UP

# OBSERVATION AND RESULTS

## AGE DISTRIBUTION

| AGE | INTERLOCKING NAILING | PLATE OSTEOSYNTHESIS |
|---|---|---|
| 21-40 YEARS | 6 | 8 |
| 41-60 YEARS | 3 | 1 |
| 61 – 80 YEARS | 1 | 3 |

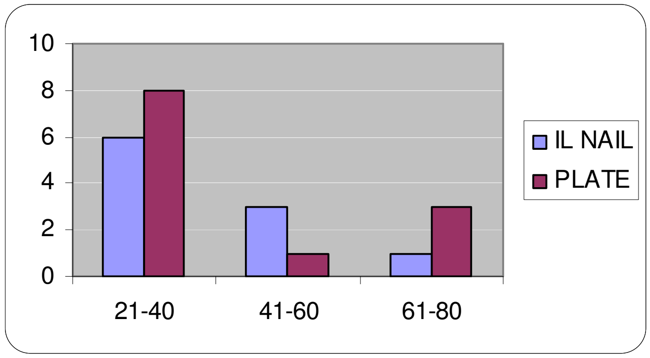
Majority of the patients taken for the study both in the Interlocking nailing group and in the Plating group are in the age group of 21 to 40 years (60 – 70%)

## SEX DISTRIBUTION

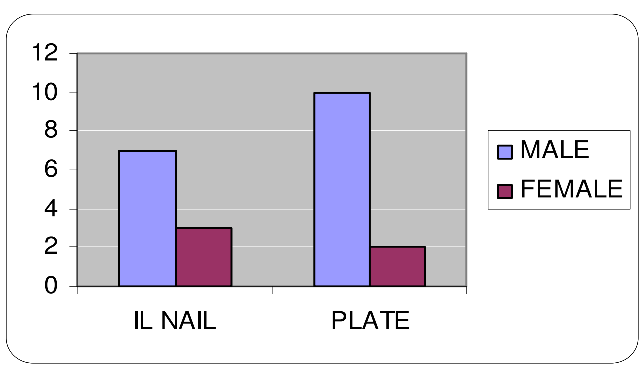
| SEX | INTERLOCKING NAILING | PLATE OSTEOSYNTHESIS |
|---|---|---|
| MALE | 7 | 10 |
| FEMALE | 3 | 2 |

Majority of the patients in the study who sustained fracture shaft of humerus are males both in the interlocking nailing and in the plating group.

AGE DISTRIBUTION




SEX DISTRIBUTION



## MODE OF INJURY

| MODE OF INJURY | INTERLOCKING NAILING | PLATE OSTEOSYNTHESIS |
|---|---|---|
| RTA | 7 | 8 |
| FALL | 2 | 4 |
| ASSAULT | 1 | - |

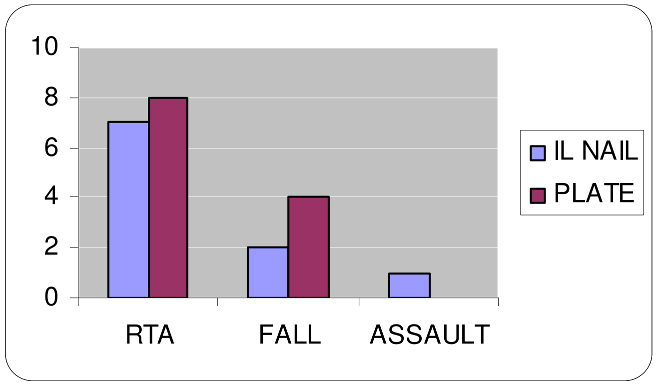
The mode of injury in most of the cases in both the groups are due to Road Traffic Accidents (70% in IL nailing group and 67% in Plating group).The remaining are due to fall and due to assault.

## SIDE OF INJURY

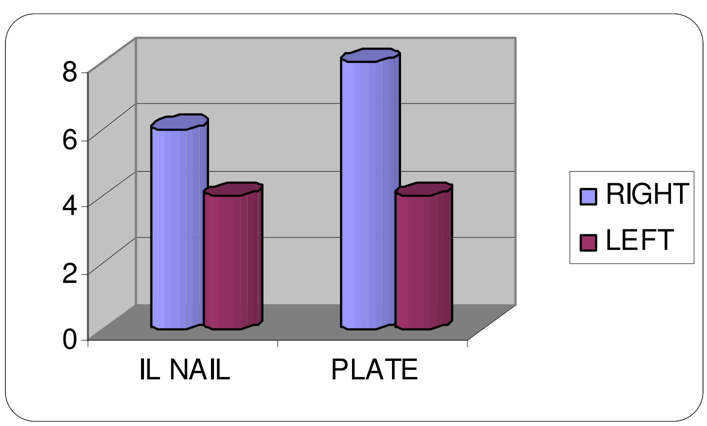
| SIDE INVOLVED | INTERLOCKING NAILING | PLATE OSTEOSYNTHESIS |
|---|---|---|
| RIGHT | 6 | 8 |
| LEFT | 4 | 4 |

50 – 60 % of the patients in the study have involvement of the dominant side in both groups.

MODE OF INJURY




SIDE INVOLVED



**FRACTURE TYPE**

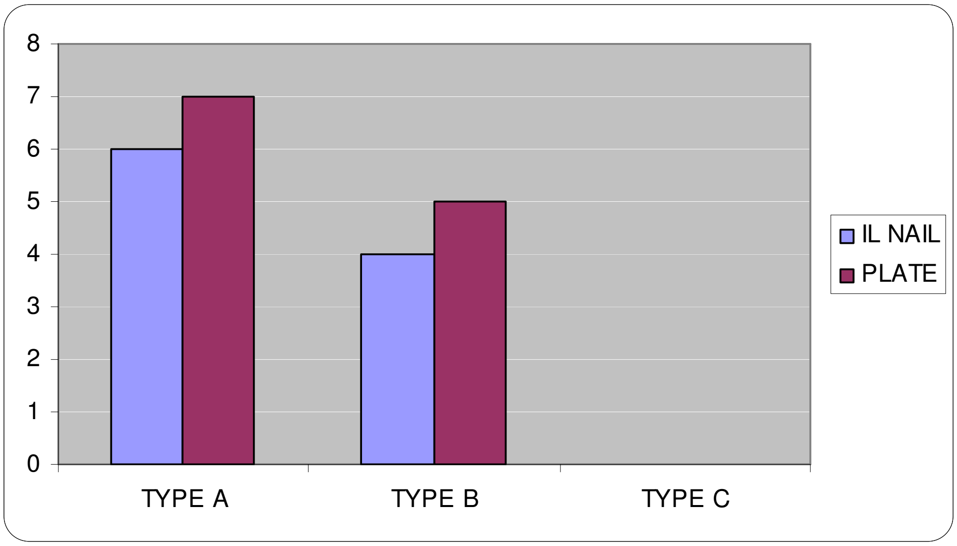
| AO TYPE | INTERLOCKING NAILING | PLATE OSTEOSYNTHESIS |
|---|---|---|
| TYPE A | 5 | 7 |
| TYPE B | 5 | 5 |
| TYPE C | - | - |

The most common type of fracture in our study in both the groups according to AO classification is Type A.The next type in frequency is Type B.

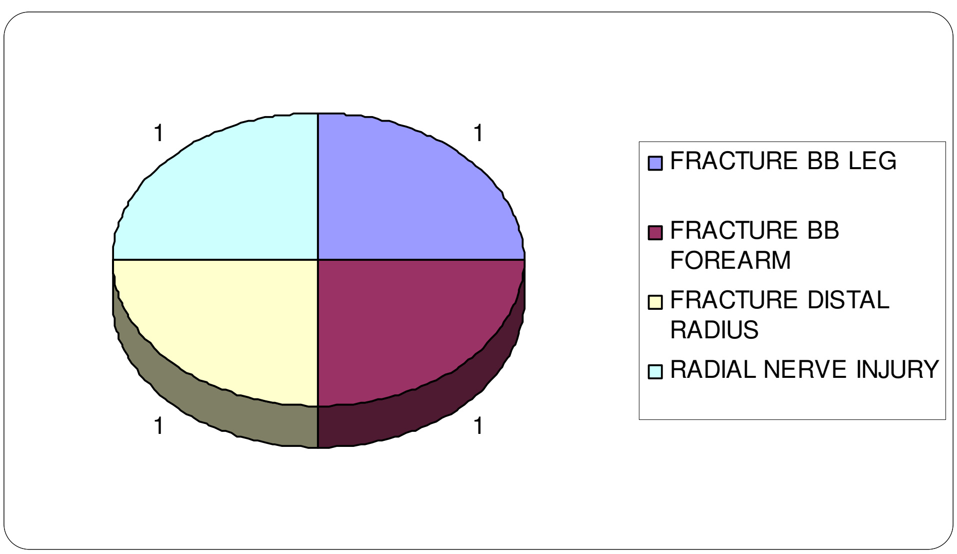
**ASSOCIATED INJURIES**

| ASSOCIATED INJURIES | NO. OF CASES |
|---|---|
| FRACTURE BOTH BONES FOREARM ON CONTRALATERAL SIDE | 1 |
| FRACTURE BOTH BONES LEG | 1 |
| FRACTURE DISTAL RADIUS | 1 |
| RADIAL NERVE INJURY | 1 |

FRACTURE TYPE




ASSOCIATED INJURIES



Comparison between plate osteosynthesis and interlocking nailing was done for

1. Time taken for Union
2. Percentage of Union
3. Functional outcome
4. Complications

1. **TIME TAKEN FOR UNION**

| S.NO | SURGICAL PROCEDURE | TIME TAKEN FOR UNION | | AVERAGE |
|---|---|---|---|---|
| | | MINIMUM | MAXIMUM | |
| 1. | INTERLOCKING NAILING | 16 WEEKS | 28 WEEKS | 22 WEEKS |
| 2. | PLATE OSTEOSYNTHESIS | 16 WEEKS | 24 WEEKS | 20 WEEKS |

The minimum time taken for union in the group treated with Interlocking nailing is 16 weeks and the maximum time is 28 weeks with an average of 22 weeks.one case went in for non – union.

The minimum time for union in the group treated with Plate Osteosynthesis is 16 weeks and the maximum time is 24 weeks with average of 20 weeks. All cases united within this period in this group.

2**. PERCENTAGE OF UNION**

| METHODS | TOTAL NO. OF CASES | UNITED FRACTURES | PERCENTAGE OF UNION |
|---|---|---|---|
| INTRAMEDULLARY NAILING | 10 | 9 | 90% |
| PLATE OSTEOSYNTHESIS | 12 | 12 | 100% |

The Percentage of fractures in the Interlocking Nailing group which went in for union without need for a secondary procedure is 90%. One case which is not united is due to distraction at the fracture site which was planned for exchange nailing .

## 3. FUNCTIONAL OUTCOME

## RODRIGUEZ MERCHAN CRITERIA

| RATING | ELBOW ROM | SHOULDER ROM | PAIN | DISABILITY |
|---|---|---|---|---|
| EXCELLENT | EXTENSION 5<br>FLEXION 130 | FULL ROM | NONE | NONE |
| GOOD | EXTENSION 15<br>FLEXION 120 | < 10% LOSS OF TOTAL ROM | OCCASIONAL | MINIMUM |
| FAIR | EXTENSION 30<br>FLEXION 110 | 10% TO 30% LOSS | WITH ACTIVITY | MODERATE |
| POOR | EXTESION 40<br>FLEXION 90 | > 30 % LOSS | VARIABLE | SEVERE |

**FOR INTERLOCKING NAILING GROUP**

**SHOULDER ROM**

| RATING | PERCENTAGE |
|---|---|
| EXCELLENT | 70% ( 7 ) |
| GOOD | 20% ( 2 ) |
| FAIR | 10% ( 1 ) |
| POOR | - |

The functional Range of Movements in shoulder joint after Nailing is excellent and good in 90% of patients and fair in 1 patient (10% ). The decrease in movement in 1 patient is due to the impingement of nail.

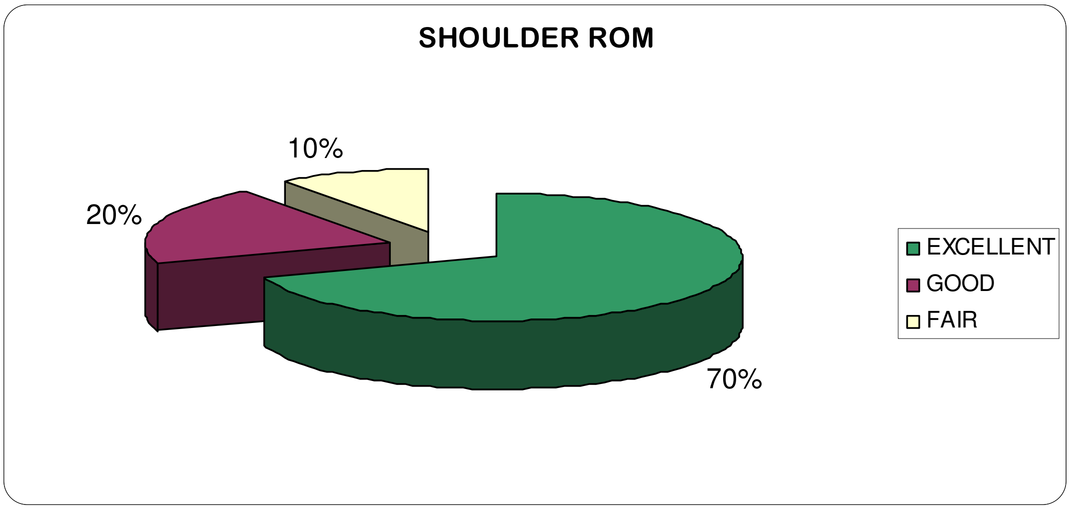
**ELBOW ROM**

| RATING | PERCENTAGE |
|---|---|
| EXCELLENT | 90% ( 9 ) |
| GOOD | 10% ( 1 ) |
| FAIR | - |
| POOR | - |

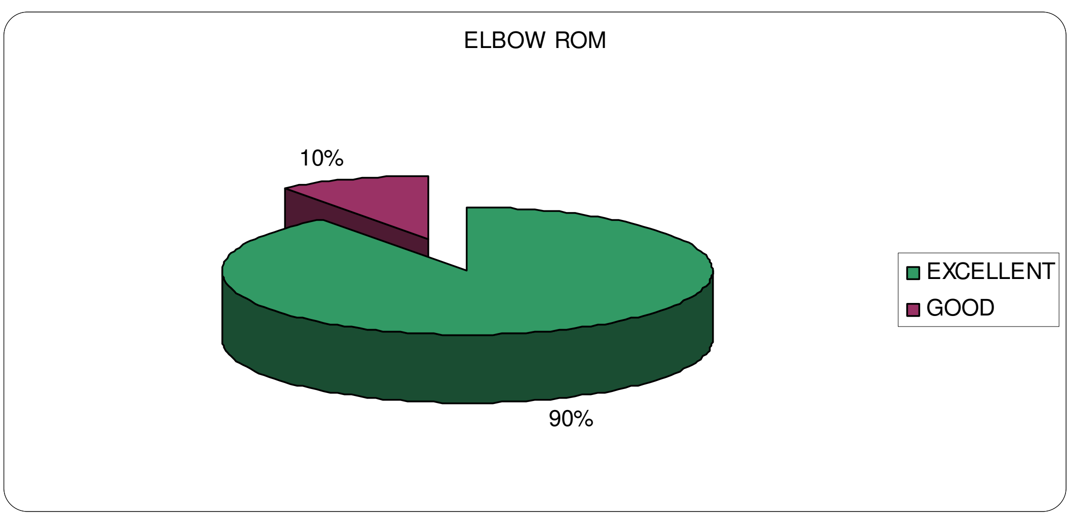
The elbow function recovered in almost all patients with 90% excellent result and 10 % has good recovery.

INTERLOCKING NAILING GROUP

SHOULDER ROM




ELBOW ROM



## FOR PLATE OSTEOSYNTHESIS GROUP

### SHOULDER ROM

| RATING | PERCENTAGE |
|---|---|
| EXCELLENT | 75% ( 9 ) |
| GOOD | 25% ( 3 ) |
| FAIR | - |
| POOR | - |

In this study 92% of cases have excellent and good results in shoulder function and 1 case had fair result.

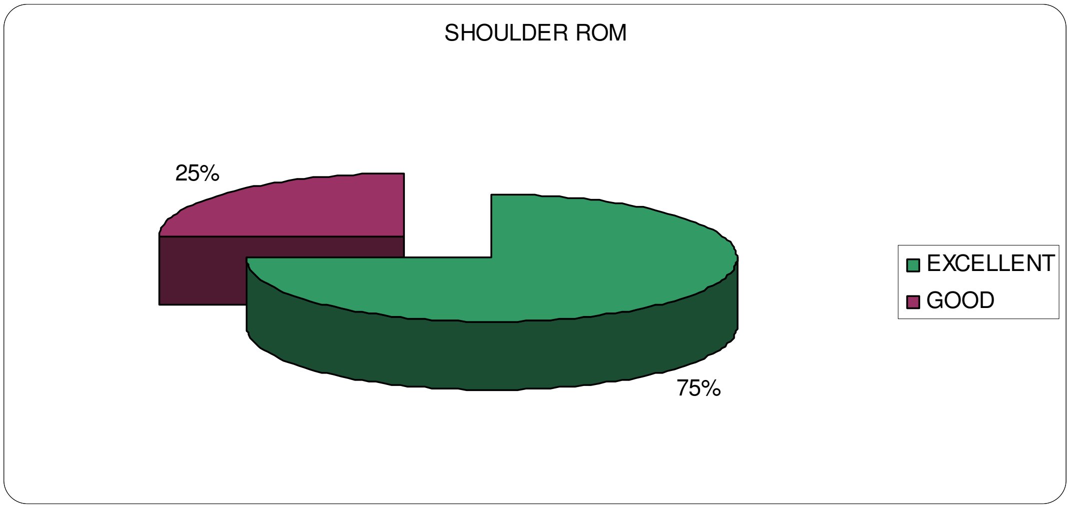
### ELBOW ROM

| RATING | PERCENTAGE |
|---|---|
| EXCELLENT | 75% ( 9 ) |
| GOOD | 25% ( 3 ) |
| FAIR | - |
| POOR | - |

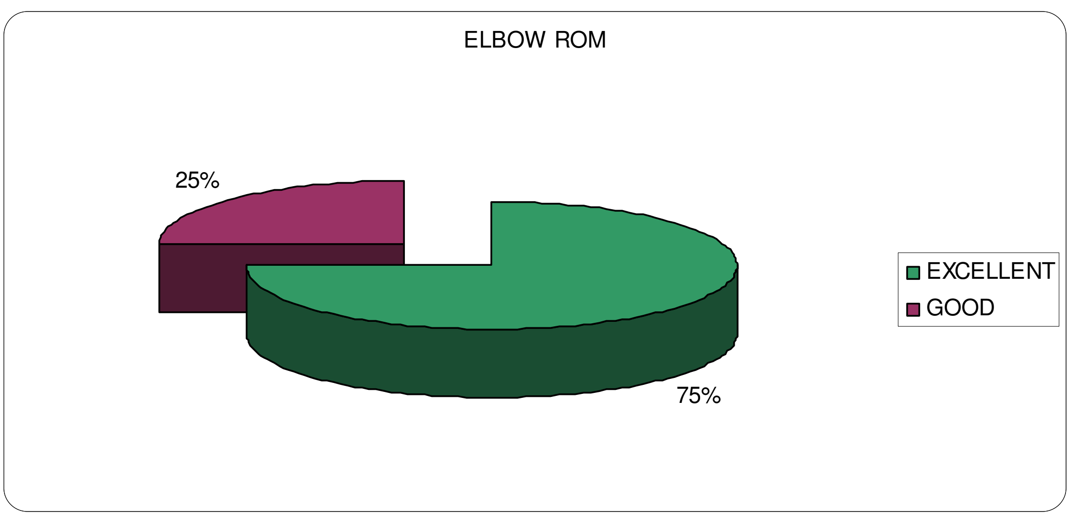
All patients treated with Plate Osteosynthesis had excellent to good functional outcome in elbow.

**PLATE OSTEOSYNTHESIS GROUP**

SHOULDER ROM




ELBOW ROM



**COMPLICATIONS**

| COMPLICATIONS | INTERLOCKING NAILING | PLATE OSTEOSYNTHESIS |
|---|---|---|
| NON UNION | 1 (10%) | - |
| SHOULDER IMPINGEMENT | 1 (10%) | - |
| INFECTION | 1 (10%) | 2 (16%) |

1. **NON UNION**:

In the group of patients treated with interlocking nailing 1 case e went in for non union (10%), for which subsequent exchange nailing was planned.

In the group treated with Plate Osteosynthesis all cases united with an average period of 20 weeks.

2. **SHOULDER IMPINGEMENT AND PAIN** :

In Interlocking Nailing group, 1 patient had shoulder impingement due to protrusion of nail due to prominence of the nail at the proximal end.

In Plate Osteosynthesis group, no cases had shoulder impingement or stiffness or pain.

3. **INFECTION** :

In patients treated with Interlocking Nailing, 1 patient in whom the fracture reduction was done by open reduction had superficial infection which settled with parentral antibiotics.

In patients who were treated by Plate Osteosynthesis, 2 patients developed superficial infection which settled with parentral antibiotics and all fractures went in for union.

# DISCUSSION

Fractures of the humeral shaft approximates 3 % to 5 % of all fractures. The treatment options ranges from conservative treatment like Coaptation Splint, Velpeau bandage, Hanging arm cast,functional brace etc. to surgical treatment like Plate Osteosynthesis, Interlocking Nailing and External Fixation.

The indications for Primary operative management of these fractures are

- Non compliant patients,
- Patient with neuro vascular deficits,
- Alignment cannot be maintained by closed methods,
- Holstein Lewis type of fracture with Radial nerve palsy,
- Bilateral fractures,
- Polytrauma patients,
- Pathological fractures,
- Floating elbow etc.

Although there have been many studies about the fixation methods of humeral shaft fractures, it is still controversial about the definitive method to be adopted for these fractures to get maximal outcome.

This study is mainly to compare the union rate of the fractures and functional outcome between the patients treated with Plate Osteosynthesis and those treated with Interlocking Nailing for fracture shaft of humerus.

In this study, the age group of the patients in both the groups ranges from 20 to 70 years with a mean age of 45 years.

Majority of the patients sustained this fracture are males and the most common mode of injury is due to Road Traffic Accident (around 70%) in both groups.

This study shows no significant difference between the time of union with an average of 22 weeks in the Interlocking Nailing group and an average of 20 weeks in the Plating group. **Raghavendra S et al** [9] in their study of 31 patients compared the time of union between the patients treated with Plating and with Interlocking Nailing concluded that there is no significant difference between the two groups.

In this study one patient in the Interlocking Nailing group went in for non-union (10%) which required secondary procedure . In a study by **AB Putti et al** [10], showed a non union rate of 8 % in patients treated with Interlocking Nailing .

The anatomical configuration of the shaft of the humerus makes it prone for residual fracture site distraction. In our study the fracture site distraction occurred in 1 patient (10%) .In a study by **Shyamasunder Bhat et al** [41]**,** they showed distraction at the fracture site during nailing in about 8.1% of cases.

In this study shoulder pain occurred in 1 out of 10 patients due to impingement of nail (10%) .This is comparable to the study by **James P. Stannard et al** [42] where they showed an occurrence of mild to moderate shoulder pain in about 20% of the patients and also in a study made by **Chapman et al** [5] there is significant reduction in shoulder movement in the Nailing group.

## CONCLUSION

In our study, there is no significant difference in the period of union of fractures after both the methods .

The chance of infection is more in the Plating group than in patients treated with Closed reduction and Interlocking Nailing patients.

The Restriction of shoulder movements are seen in patients in the Nailing group possible due to Prominent nail tip at the entry site and also due to violation of the Rotator Cuff .

Non union can occur due to distraction of the fracture site while Nailing.

The **Advantages** of Interlocking Nailing are

1. No need for open reduction of fractures as it is done under C-arm Image Intensifier.
2. Minimal soft tissue dissection.
3. Rehabilitation can started early than in case of patients in the Nailing Group.

The **Disadvantages** are :

1. Inadequate compression at the fracture site.

2. Distraction at the fracture site due to improper nail length

3. Impingement due to protrusion of nail at the site of entry.

4. Exposure to Radiation

The **Advantages** found in the Plating are

1. Adequate compression at the fracture site.

2. No need for secondary procedure.

3. Less incidence of Non union.

The **Disadvantages** are

1. Needs more soft tissue Dissection.

2. Careful isolation of Radial nerve has to be done.

3. Chances of infection is more.

4. Delayed start of Rehabilitation due to pain at the operated site.

5. Post op immobilization may be necessary in few cases.

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## PROFORMA

NAME :

AGE :

SEX :

ADDRESS :

I.P.NO :

D.O.A :

D.O.S :

D.O.D :

MECHANISM OF INJURY :

SIDE OF INJURY : RIGHT / LEFT

OPEN / CLOSED

ASSOCIATED INJURIES :

FRACTURE CLASSIFICATION : AO CLASSIFICATION

PRE – OPERATIVE COMPLICATIONS :

INITIAL TREATMENT : -

GENERAL

U-SLAB

DEBRIDEMENT IF OPEN

OTHER TREATMENTS

SURGERY:

PERIOD FROM THE TIME OF INJURY

DURATION OF SURGERY

BLOOD LOSS

**PROCEDURE FOR INTERLOCKING NAILING:**

POSITION OF PATIENT : SUPINE

APPROACH : DELTOID - SPLITTING

ENTRY POINT :

METHODS OF FRACTURE REDUCTION : OPEN / CLOSED

TYPE OF NAIL : STAINLESS STEEL ANTEGRADE NAIL

DETAILS ABOUT LOCKING : PROXIMAL AND DISTAL

SIZE OF THE NAIL :

**PROCEDURE FOR PLATE OSTEOSYNTHESIS:**

ANAESTHESIA : GENRAL / SUPRA-CLAVICULAR BLOCK

POSITION OF PATIENT : SUPINE / LATERAL

APPROACH : ANTERIOR / POSTERIOR

TYPES OF PLATES /SCREWS : DCP WITH 4.5 mm CORTICAL SCREWS

BONE GRAFTING DONE : YES / NO

POST-OP PROTOCOL

PER – OPERATIVE COMPLICATIONS:

COMMINUTION

NEUROLOGICAL INJURY

EARLY POST – OP INFECTION

DURING FOLLOW – UP :

CLINICAL : PAIN IN SHOULDER AND ELBOW

OBSERVATION :

| **RATING** | **ELBOW** | **SHOULDER** | **PAIN** | **DISABILITY** |
|---|---|---|---|---|
| EXCELLENT | EXT<br>FLEX | ABD<br>FLEX | | |
| GOOD | EXT<br>FLEX | ABD<br>FLEX | | |
| FAIR | EXT<br>FLEX | ABD<br>FLEX | | |
| POOR | EXT<br>FLEX | ABD<br>FLEX | | |

SEPSIS

RADIOLOGICAL : CALLUS FORMATION

UNION OF FRACTURE

FUNCTIONAL OUTCOME :

CRITERIA USED : RODRIGUEZ – MERCHAN CRITERIA

EXCELLENT

GOOD

FAIR

POOR

## INTERLOCKING NAILING

| S.NO | NAME | AGE | SEX | I.P. NO | MODE OF INJURY | INJURY TYPE | FRACTURE TYPE | ASSOCIATED INJURIES | INTERVAL BET. INJ & SURGERY | REDUCTION | BONE GRAFT | NAIL SIZE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | ESTHER | 45 | F | 8515 | FALL | Closed | A | | 18 days | Closed | | 7×240 mm |
| 2. | RAJENDRAN | 50 | M | 7154 | RTA | Closed | B | | 21 days | Open | YES | 7×240 mm |
| 3. | VARADHARAJ | 30 | M | 13640 | RTA | Closed | A | # Both Bones Left Leg | 12 days | Closed | | 7×240 mm |
| 4. | GOPALAKRISHNAN | 30 | M | 13033 | RTA | Grade-I open | A | | 10 days | Closed | | 6×260 mm |
| 5. | NOORJAHAN | 58 | F | 13332 | FALL | Closed | B | | 14 days | Closed | | 7×200mm |
| 6. | SRINIVASAN | 65 | M | 13618 | FALL | Closed | B | Radial Nerve. Injury | 15 days | Closed | | 7×200mm |
| 7. | PADMA | 32 | F | 14265 | RTA | Closed | A | | 15 days | Closed | | 6×240 mm |
| 8. | GOPINATH | 23 | M | 13972 | RTA | Closed | A | | 8 days | Closed | | 7×220 mm |
| 9. | MOORTHY | 38 | M | 7514 | ASSAULT | Closed | B | | 10 days | closed | | 7×240 mm |
| 10. | KANDASAMY | 30 | M | 13980 | RTA | Closed | A | | 12 days | Closed | | 7×240mm |

## INTERLOCKING NAILING

| S.NO | NAME | AGE | SEX | IP.NO | INJURY TYPE | COMPLICATIONS | TIME OF UNION | FUNCTIONAL OUTCOME |
|---|---|---|---|---|---|---|---|---|
| 1. | ESTHER | 45 | F | 8515 | Closed | - | 16 WEEKS | EXCELLENT |
| 2. | RAJENDRAN | 50 | M | 7154 | Closed | - | 16 WEEKS | EXCELLENT |
| 3. | VARADHARAJ | 30 | M | 13640 | Closed | - | 18 WEEKS | EXCELLENT |
| 4. | GOPALAKRISHNAN | 30 | M | 13033 | Grade-I open | SUPERFICIAL INFECTION | 20 WEEKS | GOOD |
| 5. | NOORJAHAN | 58 | F | 13332 | Closed | NON UNION | 28 WEEKS | GOOD |
| 6. | SRINIVASAN | 65 | M | 13618 | Closed | SHOULDER IMPINGEMENT | 24 WEEKS | FAIR |
| 7. | PADMA | 32 | F | 14265 | Closed | - | 16 WEEKS | EXCELLENT |
| 8. | GOPINATH | 23 | M | 13972 | Closed | - | 18 WEEKS | EXCELLENT |
| 9. | MOORTHY | 38 | M | 7514 | Closed | - | 18 WEEKS | EXCELLENT |
| 10. | KANDASAMY | 30 | M | 13980 | Closed | - | 16 WEEKS | EXCELLENT |

## PLATE OSTEOSYNTHESIS

| S.NO | NAME | AGE | SEX | AO TYPE | MODE OF INJURY | IP.NO | SIDE | ASSOCIATED INJURIES | INTERVAL BET. INJ & SURGERY | BONE GRAFT | PLATE SIZE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | VIJAYAKUMAR | 23 | M | A | RTA | 7581 | RIGHT | | 7 DAYS | | 10 HOLED BROAD DCP |
| 2. | VINOTH KUMAR | 21 | M | B | RTA | 21354 | RIGHT | | 6 DAYS | | 8 HOLED NARROW DCP |
| 3. | THIRUGNANAM | 45 | M | B | FALL | 21525 | RIGHT | | 24 DAYS | Y | 10 HOLED BROAD DCP |
| 4. | VENKATESWARALU | 70 | M | A | FALL | 22532 | RIGHT | | 14 DAYS | | 9 HOLED NARROW DCP |
| 5. | SHAKUNTALA | 65 | F | A | FALL | 23420 | LEFT | | 12 DAYS | | 8 HOLED NARROW DCP |
| 6. | KRISHNA SINGH | 32 | M | B | RTA | 5038 | RIGHT | | 21 DAYS | Y | 8 HOLED BROAD DCP |
| 7. | CHAIN RAJ | 33 | M | B | RTA | 22177 | RIGHT | | 9 DAYS | | 7 HOLED NARROW DCP |
| 8. | SADHIQ BASHA | 33 | M | A | RTA | 20756 | LEFT | | 27 DAYS | Y | 9 HOLED BROAD DCP |
| 9. | YUVARAJ | 29 | M | B | RTA | 23632 | LEFT | | 7 DAYS | | 7 HOLED BROAD DCP |
| 10. | MADHAN | 30 | M | A | RTA | 4485 | RIGHT | BB FOREARM LEFT | 14 DAYS | | 8 HOLED NARROW DCP |
| 11. | RAJALAKSHMI | 67 | F | A | FALL | 7225 | RIGHT | | 9 DAYS | | 7 HOLED NARROW DCP |
| 12. | MURUGAN | 40 | M | A | RTA | 22098 | LEFT | FRACTURE DISTAL | 12 DAYS | | 7 HOLED BROAD DCP |

## PLATE OSTEOSYNTHESIS

| S.NO | NAME | AGE | SEX | IP.NO | COMPLICATIONS | TIME OF UNION | FUNCTIONAL OUTCOME |
|---|---|---|---|---|---|---|---|
| 1. | VIJAYAKUMAR | 23 | M | 7581 | - | 16 WEEKS | EXCELLENT |
| 2. | VINOTH KUMAR | 21 | M | 21354 | - | 16 WEEKS | EXCELLENT |
| 3. | THIRUGNANAM | 45 | M | 21525 | - | 18 WEEKS | EXCELLENT |
| 4. | VENKATESWARALU | 70 | M | 22532 | - | 20 WEEKS | GOOD |
| 5. | SHAKUNTALA | 65 | F | 23420 | - | 18 WEEKS | EXCELLENT |
| 6. | KRISHNA SINGH | 32 | M | 5038 | SUPERFICIAL INFECTION | 24 WEEKS | GOOD |
| 7. | CHAIN RAJ | 33 | M | 22177 | - | 18 WEEKS | EXCELLENT |
| 8. | SADHIQ BASHA | 33 | M | 20756 | - | 16 WEEKS | EXCELLENT |
| 9. | YUVARAJ | 29 | M | 23632 | - | 18 WEEKS | EXCELLENT |
| 10. | MADHAN | 30 | M | 4485 | - | 16 WEEKS | EXCELLENT |
| 11. | RAJALAKSHMI | 67 | F | 7225 | SUPERFICIAL INFECTION | 24 WEEKS | GOOD |
| 12. | MURUGAN | 40 | M | 22098 | | 16 WEEKS | EXCELLENT |